PENANG AGRICULTURAL POLICY REPORT

PENANG AGRICULTURAL
POLICY REPORT

This report is prepared by

PENANG INSTITUTE
making ideas work

for Penang state government

Published in Malaysia in 2020 by Penang Institute
Penang Institute
10, Brown Road,
10350 George Town,
Penang,
MALAYSIA.

Email: enquiry@penanginstitute.org
Website: www.penanginstitute.org

Cover artwork by Kent Teh

This publication is available for download at:
www.penanginstitute.org

Preface

This report was initiated by the Penang state government, and Penang Institute is commissioned to prepare this report. The report presents an overview of the agricultural sector in Penang, an in-depth analysis of the present and historical trends, its constraints and opportunities in Penang followed by strategic actions and policy recommendations to improve productivity, sustainability, farmers' income, food security and competitiveness of the sector. This report provides the framework for stimulating, guiding and directing sustainable agricultural growth and development. It covers three sub-sectors: crops, livestock and fisheries.

Acknowledgements

Our deepest appreciation goes to Penang Economic Planning Division (BPEN), Department of Agriculture (DOA) Penang, Department of Veterinary Services (DVS) Penang, Department of fisheries (DOF) Penang, Fisheries Development Authority of Malaysia (LKIM) Penang, and Halal Management Division Penang for their contributions and guidances in preparing this report. We also like to thank the Penang Island City Council (MBPP), Seberang Perai Municipal Council (MPSP), Land Administration Division District and Land Office North of Perai Penang, Federal Agricultural Marketing Authority (FAMA), Malaysian Agricultural Research and Development Institute (MARDI) and Integrated Agricultural Development Area (IADA) for their comments and feedback on this report. We are grateful to fishermen and small scale fisheries community at Teluk Bahang Kampung for their support and willingness to share their experiences with us.

The project was conducted by Dr. Negin Vaghefi, Senior Analyst affiliated with Penang Institute. Our special thanks go to Mr. Hazim Oon and Mr. Alaguraja Palaniappan who contributed towards gathering relevant information and data, as well as interviewing experts.

Contents

Abbreviations

AIZ	Aquaculture Industrial Zones
AWD	Alternate Wetting and Drying
BOT	Balance of Trade
21 CV	21st Century Villages
DOA	Department of Agriculture
DOF	Department of Fisheries
DVS	Department of Veterinary Services
FAMA	Federal Agricultural Marketing Authority
FELCRA	Federal Land Consolidation and Rehabilitation Authority
FELDA	Federal Land Development Authority
GDP	Gross Domestic Product
GMP	Guaranteed Minimum Price
ICT	Information Communication Technologies
IoT	Internet of Things
LKIM	Fisheries Development Authority of Malaysia
MARDI	Malaysian Agricultural Research and Development Institute
MOA	Ministry of Agriculture and Agro-Based Industry
NAFP	National Agro-Food Policy
NAP1	First National Agricultural Policy
NAP2	Second National Agricultural Policy
NAP3	Third National Agricultural Policy
NGO	Non-profit Organization
PCC	Per Capita Consumption
PEMANDU	Performance Management and Delivery Unit
PPP	Public-Private Partnership
R&D	Research and Development
SME	Small and Medium Enterprises
SPM	Sijil Pelajaran Malaysia
SSF	Small-scale Fisheries
SSL	Self-Sufficiency Level
TKPM	Taman Kekal Pengeluaran Makanan
TUT	Tabung Usahawan Tani
AIZ	Aquaculture Industrial Zones

Figures

Tables

1. Executive Summary

1.1 Introduction

Although the Malaysian economy continues to grow, the agriculture sector has diminished during this transformation into an industrialised country. Since the 1980s, the manufacturing sector has been the economy's leading growth sector, with its contribution to the gross domestic product (GDP) surpassing that of the agricultural sector. The agricultural sector's share of the GDP has dropped from 29.9% in 1970 to 18.7% in 1990, and finally to7.8% in 2018. The Malaysian agricultural sector has not grown in tandem with the non-agriculture sector; for example, the value-add and productivity in this sector is far below the industrial sector. Although the manufacturing and service sectors are currently the main engines of growth, the government is still planning to expand the agricultural sector. Diversifying the sources of growth in the economy will generate stable revenue for the country.

More than just an economic entity, agriculture offers a degree of food security – it provides access to adequate, safe and nutritious food for the growing population. It is also an important supplier of raw materials for resource-based industries. Furthermore, sustainable agriculture contributes a set of environmental goods and services such as cleaner air, water as well as fostering wildlife habitat diversity.

The main purpose of the Penang Agricultural Policy Report is to address two key questions:

i. What is the future of agriculture in Penang?
ii. What strategies and policies are required to achieve this future?

In fact, the transformation of agriculture into a productive, modern, high-value market-oriented sector with forward linkages to other sectors is an important objective of this Policy Report. In Malaysia, there are two types of agriculture: food production and plantation. This report focuses on food production policies.

The development of this report was the result of a process of extensive consultation with stakeholders as well as the analysis of trends, statistics and a review of past and current policies. Indeed, great opportunities for agriculture exist in Penang, but an array of challenges remain. These are mostly resource constraints (land and labour), dependence on imported raw materials and vulnerability to climate change and disease.

1.2 Vision

The vision of this policy report is to transform the agriculture sector into a productive, modern, sustainable, high-value, competitive and knowledge-intensive sector.

1.3 Planning Principles

In line with the National Agro-Food Policy (NAFP) 2.0 (2021-2030) and Penang2030 (theme B and strategic initiative B2), the Penang Agricultural Policy Report will be guided by the following broad principle:

Modernising the sector, diversifying sustainable agriculture and increasing the efficiency of the agro-food industry along the value-food chain to make the industry more productive, competitive and knowledge intensive.

Additionally, the recommended policies are supported by the following operating principles:

i. The long-term success of agriculture can only be secured with strong support and integrated efficient land use, food and agriculture sector development as well as infrastructure policies.
ii. Changes in agriculture are continuous and need monitoring as well as a dynamic response to emerging trends and opportunities in both urban and rural areas.
iii. Agriculture, especially the agro-food industry, must remain a competitive and sustainable industry that can enhance the income of farmers, smallholders and agriculture entrepreneurs.

1.4 Objectives

The Penang Agricultural Policy Report has the following objectives:

i. To develop a detailed understanding of current and historical agricultural capacity, its constraints and opportunities in Penang;
ii. To determine the types of agriculture and/or related agricultural activities that have potential for success over the long term; and
iii. To recommend agricultural policy to improve productivity, sustainability, farmers' income, food security and competitiveness of the sector.

2. Introduction

2.1 Overview of Agricultural Development in Malaysia

The agriculture sector plays an important role in the economic development of the country, functioning as a food supplier, employment provider, export earner and provider of raw materials for agro-based industries. The development path of this sector has seen different mixes of strategies and policies driven by goals that shifted based on the demands of time. Generally, the agricultural policy in Malaysia was established during two periods: before independence (1948-1957) and after independence (1957-2020). The shift in development focus started with the introduction of the First Malayan Plan (1956-1960) and Second Malayan Plan (1961-1965).

Prior to independence, the agricultural policy emphasised on the plantation of commercial crops such as oil palm, cocoa and rubber. During this period, the contribution of the agriculture sector was significant (Dardak , 2015). After independence, its contribution was even greater because of government policies to develop the full potential of this sector as the backbone of the country's economy. During this time, policies mostly focused on enhancing farmers' income and reducing poverty among them.

The period from 1984 to 1990 saw the rapid development of the manufacturing sector and changed the relative importance of the agricultural sector. The overall decline of the agricultural sector was influenced by favourable policies towards manufacturing, labour shortages, increasing cost of production and competition for land with other sectors.

The task of revitalising the agricultural sector falls to the Ministry of Agriculture and Agro-Based Industry (MOA). Its main goal is boosting the development of agriculture and agribusiness in the country. Although divided into several agencies and departments specialising in different sectors, there is some overlap between their tasks. According to Zainal Abidin Mohamed (2014), the MOA is comprised of the following agencies and departments:

i. Malaysian Agricultural Research and Development Institute (MARDI)
ii. Federal Agricultural Marketing Authority (FAMA)
iii. Fisheries Development Authority of Malaysia (LKIM)
iv. Farmers' Organisation Authority
v. Agrobank (formerly Bank Pertanian Malaysia)
vi. Muda Agricultural Development Authority
vii. Kemubu Agricultural Development Authority
viii. The Malaysian Pineapple Industry Board
ix. Department of Veterinary Services (DVS)
x. Department of Agriculture (DOA)
xi. Department of Fisheries (DOF)

2.1.1 National Agricultural Policies

After independence, Malaysia formulated four agricultural policies to stay competitive in the agriculture and agro-based industry, while maintaining food security and affordability. These policies are:

i. The first National Agricultural Policy (NAP1) (1984-1991);
ii. The second National Agricultural Policy (NAP2) (1992-1997);
iii. The third National Agricultural Policy (NAP3) (1998-2010); and
iv. The NAFP (2011-2020).

The NAPs were meant to complement and be implemented together with the other development policies, such as the National Development Policy, the Second Industrial Master Plan, the Science and Technology Policy and the National Biodiversity Policy to assist economic development and to achieve developed status by 2020.

NAP1 was established as a comprehensive and coordinated long-term policy to address the issue of rural poverty and income inequality between commercial and traditional farmers, since the previous policies failed to reduce poverty and enhance the performance of the agriculture sector. It was also designed to ensure the balanced rate of growth of the agricultural sectors relative to other sectors in the economy. This policy mostly emphasised poverty alleviation among traditional smallholder farmers and increasing the value-add of agricultural production for export markets. During this time, Malaysia had abundant labour and enough land for agricultural activities. Agrarian reform helped to create employment, especially in rural areas, therefore enhancing the output of the agro-food industry.

NAP2 was introduced to address important shortcomings of the NAP1. This policy aimed to maximise farmers' income through effective and efficient resource utilisation; achieve balanced development between the agriculture and manufacturing sectors; enhance the integration of the sector with the rest of the economy – particularly manufacturing –; and to develop the food industry. In fact, the main objectives of this policy were to increase production, competitiveness and sustainable production. The strategies used to achieve these objectives include optimising resource utilisation to diversify export crops cultivation into other activities; accelerating agro-based industrial development for the benefit of smallholders; enhancing research and development (R&D) to overcome production processes, labour shortages and other limitations; maximising participation of the private sector to transform the sector into a more competitive sector; and improving human resource development through training.

NAP3 was introduced after the government witnessed the effects of the Asian financial crisis of 1997/1998, and the liberalisation of the financial markets to Malaysia's economy. The direct impact of the Asian financial crisis on the Malaysian economy was the depreciation of the currency, reversals of net capital flows and strains on the financial sectors, which caused a negative economic growth in 1998. During this time, the growth rate of agriculture was 4%. The food import bill also increased by about 37% from 1995 to 1998. In fact, the depreciation of the ringgit put pressure on prices, and food prices experienced the largest increase. As a result of these setbacks, the government decided to come up with new strategic approaches and policy thrusts to improve the economic contribution and growth of the agriculture sector. NAP3 was formulated to address the issues such as changes in the economic structure because of land and labour shortages, optimal resource utilisation to enhance competitiveness, and food security issues.

The main objectives of NAP3 were to enhance food security; boost productivity and competitiveness of the sector; strengthen linkages with other sectors; create new sources of growth for the sector; and to conserve and utilise resources sustainably. NAP3 employed two strategic approaches: agro-forestry and product-based approaches. The agro-forestry strategy was adopted to integrate agriculture and forestry development outside Permanent Forest Estates. This strategy views agriculture and forestry as mutually compatible and complementary, hence providing a scope for mutually beneficial joint development by providing a larger productive base for both forestry and agriculture. Therefore, it addressed resource constraints such as labour and land. Meanwhile, the product-based approach aimed to address the importance of consumers' preferences and potential as well as the domestic and global markets. This approach is adopted to strengthen both inter- and intra-sectoral linkages including growth and development of intermediate and supporting industries.

The success of the previous NAPs and the need to reform and transform the agricultural sector, coupled with the rise in global food prices in 2008, led the government to launch the NAFP (2011-2020). The NAFP specifically addresses issues and challenges in domestic and global markets to ensure sustainable production for food safety and security; competitiveness and sustainability of the agro-food industry; and to increase the income level of agropreneurs. It mostly focuses on modernising the efficiency of the agro-food industry to make the industry more productive, competitive and knowledge intensive.

The main programmes implemented under the NAFP include increasing food production by optimising sustainable land use; developing and upgrading agricultural infrastructure; and increasing the quality and safety of food by expanding compliance standards. Efforts have also been taken to strengthen human capital and to create a skilled labour force for the agricultural sector. This includes the use of modern technology and mechanisation to reduce dependency on manpower. The government also provides sector-based incentives to encourage the private sector to invest in agriculture and agro-based industries.

Currently, the government is drafting the Agro Food Policy 2.0 (2021-2030) in order to accelerate the modernisation of the agro-food sector as well as balance national food supply and demand. The main aims of this policy is to ensure food security and increase the contribution to the livelihood of the target group and national economy. It is in line with Industrial Revolution (IR) 4.0 and Sustainable Development Goals (SDGs) 2030.

At the state level, the Penang Structure Plan focuses on agricultural policies in terms of protecting agricultural land while increasing the productivity of this sector through biotechnology and modern and efficient management methods. In addition, modernising and diversifying the agriculture sector to increase yield and produce higher value products is one of the main strategic initiatives of Penang2030. It aims to position Penang as a high-tech Green Valley, aquaculture industrial zone, as well as halal hub. It also intends to develop digital know-how to bridge the gap between raw skills and technology, as well as to enable investment for R&D and talent development in the agriculture sector. Feeding Penang initiative will also be introduced to create more localised and urbanised farming to ensure food security.

3. Sector Analysis

3.1 Agricultural Land Use in Penang

Before the adoption of the industrialisation policy in the 1970s, Penang was heavily forested and its economy was largely based on agriculture and regional trading. Since 1970s, Malaysia and Penang have experienced rapid urbanisation. Penang's economy diversified, transforming from a resource-based economy into a one steeped in trading and manufacturing. In fact, the economy at large was focused mainly on pursuing industrialisation and urbanisation to enhance exports and foster economic growth. It put pressure on farmland as well as rural communities, whose livelihoods depend on agricultural activities. It also caused a huge rural-urban migration (El Hadary et al., 2011). Worryingly, agricultural land was turned into industrial and residential areas to meet the needs of rapid economic growth and the increase in urban population, reducing the availability of farmland for food.

Located in Peninsular Malaysia, Penang's total land area covers 1,046 km2. In 2016 agricultural hectarage (crops and livestock) accounted for about 34.2% of total land usage in Penang. Crop land use decreased in trend from 1999 to 2016, especially for cocoa, coconut, vegetables and fruits (Table 1: Cropland in Penang (hectares), 1999-2016). After industrial crops (rubber, oil palm and coconut), paddy fields use the highest percentage of total agricultural land in Penang.

Table 1: Cropland in Penang (hectares), 1999-2016

	1999	2003	2007	2011	2016	% Change (1999-2016)
Paddy	14,062.5	13,448.0	12,782.0	12,782.0	12,782.0	-9.1
Fruits	7,396.9	6,802.2	6,747.1	6,921.1	4,715.7	-36.2
Rubber	13,097.2	12,758.2	10,837.6	10,837.6	-	-
Oil Palm	13,182.1	12,988.0	13,504.2	13,864.6	-	-
Coconut	2,481.0	2,313.0	2,036.9	1,991.8	329.1	-86.7
Cocoa	141.3	75.4	9.4	8.2	0.0	-100.0
Vegetables	1,711.0	403.7	409.8	477.2	715.4	-58.2
Cash Crops	-	241.9	217.3	236.8	176.0	-
Spice Crops	149.2	79.3	122.2	251.0	138.3	-7.3
Sugar Cane	-	-	-	37.3	42.9	-
Others	415.8	89.4	24.0	32.2	1.0	-99.8
Total	**52,637.0**	**49,199.1**	**34,036.3**	**47,439.8**	**18,900.4**	**-**

Source: Department of Agriculture, Penang

3.2 The Paddy and Rice Industry

3.2.1 Introduction

The paddy and rice industry in Malaysia, which is the third-most important crop after rubber and oil palm, has always been given special treatment because rice is a staple food of the country. The per capita consumption (PCC) of rice showed an increasing trend from 78.6 kg/year in 2014 to 79.5 kg/year in 2016 ("Supply and Utilization", 2018). In fact, the continued population growth calls for more research and technological advancements to increase rice production for consumption in the country. Seberang Perai, as one of the ten major granary areas and the hub of paddy production in Peninsular Malaysia, contributes significantly to domestic production in the country. Yet total rice production in Penang is unable to meet domestic demand. Land utilisation for paddy production is currently at 12,782 hectares – nearly 30% of total agricultural (crop sub-sector) land use in the state. There are about 7,057 paddy farmers, mostly concentrated in North Seberang Perai (Mok , 2016).

The industry is highly regulated and subsidised due to its social, political and economic significance. Measures for improving farmers' standards of living have been undertaken by the government, since the industry has been historically associated with poverty.

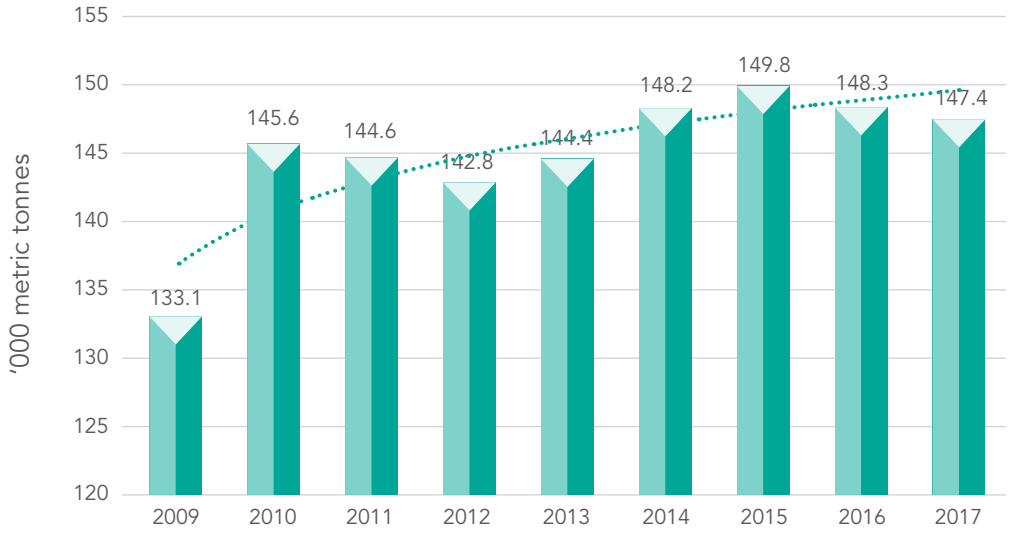
3.2.2 Paddy Production

In 2017, Penang produced 147,373 metric tonnes of paddy, up from 133,050 metric tonnes in 2009 (Figure 1). Rice production grew significantly by about 10.7% from 2009 to 2017. There was a notable reduction in Penang's rice yield in 2017 due to flash floods that November. The Self-Sufficiency Level (SSL) plays an essential role when it comes to food security issues. Based on the national rice PCC of about 79.5 kg/year[1] and Penang's total population of 1.7 million, rice needs in Penang in 2017 were estimated at 138,862.7 metric tonnes. With a total rice production of 95,792.5 metric tonnes[2] in 2017, Penang's rice SSL was calculated to be about 69%; the remainder needed to be imported to fulfil market demand. Nevertheless, with the increase in per capita income and changes in consumption patterns and lifestyle, the percentage share of the total caloric supply from rice has significantly declined (Omar et al., 2019). However, rice still remains the main source of carbohydrate in Malaysia and its consumption is expected to increase further.

[1] The PCC of rice for 2017 is not available. Hence, it is assumed that the rice PCC stayed at its 2016 level (Department of Statistics, 2018).

[2] Assuming a paddy to rice conversion rate of 65.0%.

Figure 1: Paddy Production in Penang, 2009-2017



Source: Department of Agriculture, Penang

3.2.3 Paddy Policies

Many policies were introduced by the government to develop the rice industry. In fact, paddy and rice development strategies and policies were introduced before independence. However, there were no significant support programmes particularly in terms of the development of infrastructure and R&D. Due to the introduction of new supportive programmes for farmers and the industry after independence, the SSL of rice increased significantly. As a result of large public investment as well as the double cropping system, the production of rice dramatically increased.

The government continued to develop the rice industry through the NAPs. The development of the granary areas made an important impact on rice productivity. Today's NAFP has six strategies for strengthening the rice industry:

i. enhancing the productivity and quality of rice;
ii. increasing efficient mechanisation and automation;
iii. intensifying the use of rice by-products;
iv. strengthening rice stockpile management practices;
v. restructuring incentives and subsidies for rice; and
vi. strengthening the institutional management of paddy and rice.

Government support and initiatives play an essential role in the development of the rice industry; the main aim is to achieve the self-sufficiency targets and improve the market. Current government policies mostly focus on production incentives; the development of irrigation and drainage infrastructure and facilities; R&D; and farm mechanisation programmes and projects.

In terms of production incentives, the government has introduced the Guaranteed Minimum Price (GMP) policy for paddy, paddy price subsidies, and input or fertiliser subsidies to raise yield and farmers' income. The paddy price policy was specifically implemented to increase the market price of paddy to enhance the income and livelihood of paddy farmers.

The objective of the GMP was to ensure that they receive a reasonable minimum farm income to alleviate poverty. Therefore, the price of paddy would remain above or at the GMP level. Due to the increase in input prices and labour cost, the GMP rate increased to RM1,200 per tonne in 2014.

The latest data shows that the total cost of production for paddy farmers who owned the land is about RM4,981 per hectare; and RM5,801 per hectare for tenant farmers (Table 2). Fertiliser is the biggest expense but it delivers the highest yield. Since the cost of production for paddy is quite high, the government provides paddy farmers with input subsidies to reduce increasing costs, especially chemical and fertiliser inputs. Positive results, such as increasing farm productivity and income as well as poverty alleviation among farmers, have been achieved. This incentive was also meant to encourage paddy farmers to properly apply fertiliser based on recommendations by government institutions, such as MARDI. Farmers were also encouraged to increase productivity, therefore getting closer to attaining the targeted productivity and SSL.

Table 2: Total Cost of Rice Production per Hectare Using Direct Seeding in Penang, 2017

No.	Item	RM
Input Cost		
1.	Seed	280.0
2.	Fertiliser (including subsidies and incentives)	1,166.6
3.	Herbicides	250.0
4.	Pesticide	200.0
5.	Fungicide	335.0
6.	Rat Poison	150.0
7.	Snail Poison	80.0
8.	Lime	320.0
9.	Other Chemical	200.0
Total (i)		**2,981.6**
Labour and Operation cost		
1.	Cutting dried grass/hay	70.0
2.	Burning dried grass/hay	20.0
3.	Plough	450.0
4.	Operation for rat poison	20.0
5.	Operation for Snail Poison	20.0
6.	Weed control before planting	80.0
7.	Swing seeds	70.0
8.	Replanting	35.0
9.	Weed control after planting	80.0
10.	Creating working lane	40.0
11.	Pesticides and disease	240.0
12.	Fertiliser	360.0
13.	Harvesting and transport	500.0
Total (ii)		**1,985.0**
iii	Renting the land	835.0
iv	Land/irrigation tax	15.0
Total cost for landowner (i)+(ii)+(iv)		**4,981.6**
Total cost for tenant (i)+(ii)+(iii)		**5,801.6**

Source: Department of Agriculture, Penang

3.2.4 Issues and Challenges

Although rice production in Penang increased, the industry still faces many challenges. Urbanisation, industrialisation and the expansion of residential areas have resulted in limited available farmland. The conversion of land to non-agricultural or non-paddy agricultural purpose is a serious threat to the food security – especially in Seberang Perai, which has undergone much urbanisation over the past decade. The power to allow this conversion lies with the city council and the district office. However, it should be noted that paddy fields are categorised as "First Grade" land, and therefore landowners do not need permission from the state government to convert their property (Kee , 2018).

Promising and attractive employment in the industrial sector has caused an acute labour shortage. Furthermore, the lack of acceptance of modern farming practices (particularly among farmers above 60 years old) and rice processing equipment has resulted in slower production growth.

Irrigation is another challenge. Penang draws most of its raw water for domestic use, industrial use and irrigation of paddy fields from Kedah's Sungai Muda. Being too dependent on one source, particularly with increasing water demand in both Penang and Kedah, is risky especially during water crises. In addition, the government prioritises human consumption and cuts water for irrigation purposes during bad weather conditions such as droughts, which in turn affects farming operations. It has also been projected that Sungai Muda may only be able to support Penang's raw water needs until 2025 (Sim , 2019). This indicates the need for new approaches in water management.

The rice mills produce large amounts of by-products, such as broken rice, rice husk and rice bran, which are still not fully utilised in Penang and Malaysia. For example, by-products such as paddy straw and rice husk can potentially be used to generate electricity and can be turned into a biomass resource, but infrastructure such as rice by-product reprocessing facilities are lacking. An increase of paddy residue would lead to waste management and pollution problems if not properly managed.

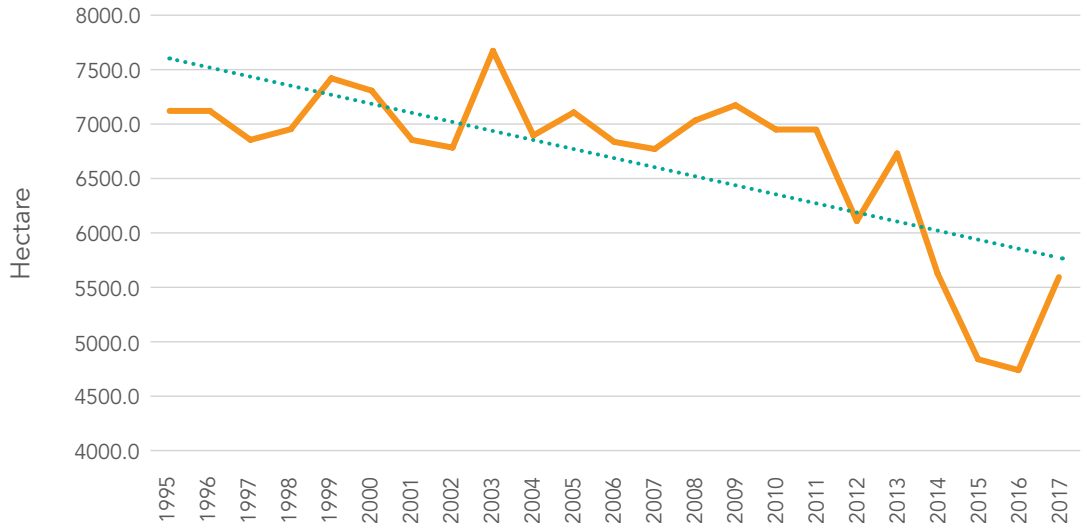
As land and water resources are limited in Penang, innovative ways to enhance the rice productivity is required. It is vital to know the actual and up-to-date total area planted with paddy to provide precise yield measurement, land use prediction, farm monitoring, as well as to predict the expected harvest. More focus on R&D and improvements in sustainable farming practices are needed.

3.3 The Fruit Industry

3.3.1 Introduction

Malaysia has a climate suitable for the cultivation of tropical fruits. With 5,570 hectares of land allocated for fruit cultivation in Penang, it is obvious that the industry is substantial to the economy. Penang produces a variety of fruits. Among the economically important ones are durians and pineapples – planted mainly in the south-west and South Seberang Perai districts respectively. There is potential growth in local consumption and export opportunities. However, land used for fruit cultivation in Penang has been steadily decreasing. The planted area of fruits in Penang has seen a 21.5% decline between 1995 and 2017 (Figure 2). This is mostly due to the increase in land allocation for residential and development purposes and competition from other sectors.

Figure 2: Fruit Farmland in Penang, 1995-2017



Source: Department of Agriculture, Penang

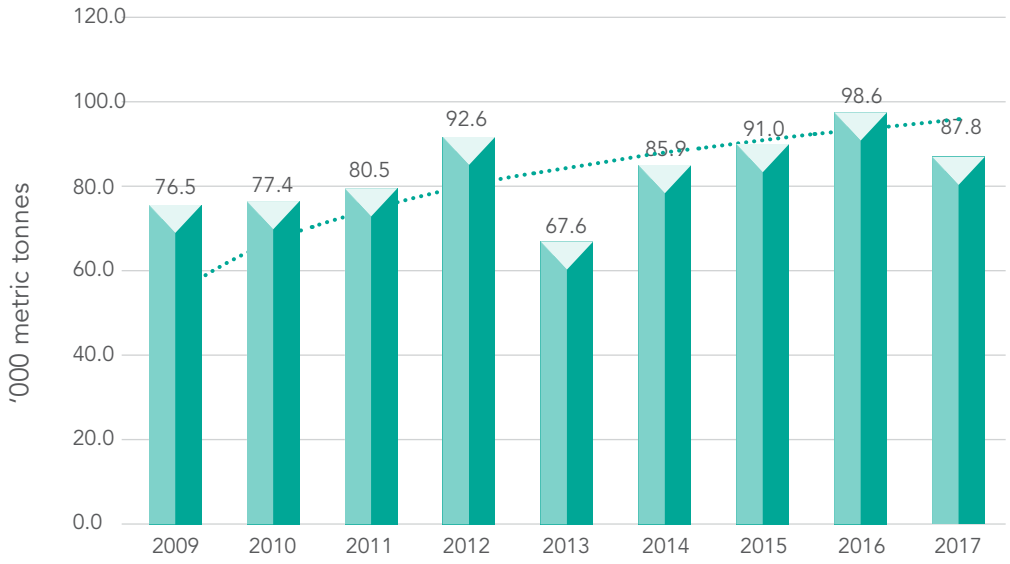
The agricultural sector in Malaysia has always been geared towards the production of export commodities such as palm oil, rubber and cocoa. Food industry, apart from paddy, has not received the adequate support it needs to develop since the government is keener to develop export crops. Hence, the potential sub-sectors for the food industry – such as fruits, vegetables and livestock – did not develop, which explains Malaysia's heavy dependency on imported fruits, vegetables, feedstuffs, dairy products and processed food items.

3.3.2 Production and Consumption

Due to a rising population and average incomes, the PCC of fruits has been increasing, albeit a very slow pace (approximately 0.2% annually) (MOA, 2015). According to the NAFP, domestic demand for tropical fruits is expected to rise from 2.7 million metric tonnes in 2010 to 3.4 million metric tonnes by 2020. If provided with the right incentive, it is not difficult for farmers to meet growing domestic demands.

Since there is a high demand for land from other sectors, the fruit industry faces intense competition. This is worsened by climate change, which results in unpredictable weather. Since 2009, Penang's output has been steadily increasing (Figure 3). The reduction in planted area suggests that there has been an increase in average yield per hectare, or productivity, in Penang. If this rise in productivity is coupled with an increased land allocation to the industry, the problem of self-sufficiency can be manageable.

Figure 3: Fruit Production in Penang, 2009-2017



Source: Department of Agriculture, Penang

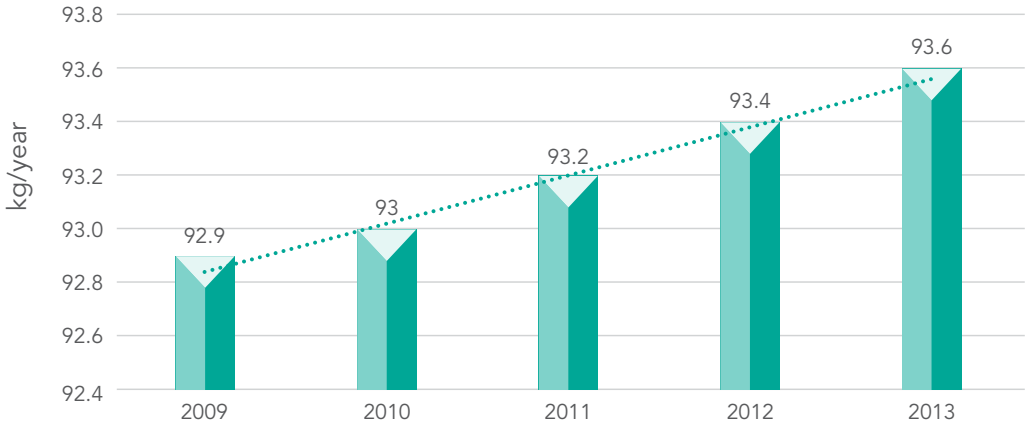
The NAFP predicts that the production of fruits in the country will increase to 2.6 million metric tonnes by 2020, and identified papayas, pineapples, watermelons, durians and bananas as having the highest potential for growth. NAFP proposes the commercialisation of the fruit industry for export, improving the supply chain and controlling crop-related diseases. It aims to commercialise the fruit industry by allocating more land to the sub-sector. An additional 23 million hectares of unused land in the country will be developed into fruit farms in order to meet growing domestic and global demand. These newly developed lands will be provided with basic infrastructure, and developed based on the contract farming concept. The NAFP also suggests the use of freezing and modified atmospheric packaging to increase the shelf-life of fruits.

In an effort to control crop-related diseases, the NAFP aims to collaborate with MARDI to increase R&D in order to make crops plague-resistant. It also encourages an integrated pest management system and the enforcement of the biosecurity system[3] to prevent the spread of disease. The policy plans to improve marketing and supply chain processes by establishing a National Fruits Council. This council will be given the responsibility of monitoring fruit prices and fruit safety of Malaysia as well as protecting domestic producers.

As illustrated in Figure 4, the PCC of fruits has skyrocketed from 2009 to 2013. The numbers in this figure shows an approximate 67% increase from the fruit PCC in 2002 (56%) (Arshad et al., 2007) and is expected to grow along with improving standards of living and increasing health awareness among consumers.

[3] Biosecurity is a process of managing biological risks associated with food and agriculture in a holistic manner. It covers the incidence of plant pests, animal pests and diseases, the introduction and release of genetically modified organisms and their products, as well as the occurrence and management of invasive alien species and genotypes.

Figure 4: Domestic Per Capita Consumption of Fruit, 2009-2013



Source: Ministry of Agriculture and Agro-Based Industry, Malaysia.

3.3.3 Fruit Marketing

There are different fruit marketing channels. At the farm level, farmers can either sell their products directly to traders, wholesalers or via their commission agents or assemblers (who usually work for wholesalers). The wholesalers sell the produce to retailers, who later sell to the consumers. There are also some farmers who sell directly to the processors. In addition, the farmers can sell their products directly to consumers or through private traders in mobile markets (e.g. pasar tani) (Zakaria , 2014).

Fruit distribution is mostly done through wholesalers and collectors but interest in direct marketing is increasing. It directly links urban consumers and rural food producers, which in turn contributes to the rural economy by providing alternative marketing channels. Farmers receive higher gains from selling direct to consumers compared to the middlemen. Furthermore, consumers value fresh, quality products along with the opportunity to support local producers.

Direct marketing improves farmers' business opportunities and encourages business skills. It is an opportunity for start-ups in the agriculture and food industries, while simultaneously boosting food security. Public support is needed, but for now there is still poor contact between mass buyers (i.e. hypermarkets) and farmers as well as a lack of transportation options for the farmers.

3.3.4 Issues and Challenges

The fruit industry suffers from a high cost of production, inconsistency in supply, market access, and food safety and quality standards. The increasing cost of production can be attributed to labour shortages, dependency on imported raw materials and limited land area for fruit cultivation. The fruit sub-sector is becoming more and more unpopular among the young generation. As a result of labour movement from the agriculture sector to industrial sectors, which provide higher returns, foreign labour is needed to fill the gap.

Due to competition from other sectors, the fruit sub-sector is also a victim of decreasing land allocation. Although government initiatives have helped to increase productivity, limited land availability leads to inadequate supply of fruits. In addition, input such as fertiliser is still mostly imported even though there is a local supply. Geographically scattered farmers and a lack of commercial fruit farmers can lead to inconsistency in supply. Small, uneconomic and fragmented farmers lack the motivation to increase production and maximise profit. Due to their lack of market knowledge, domestic farmers are unable to tap into the growing global demand for tropical fruits.

Good agricultural practices and quality standards must be met in order to export tropical fruits. Due to excessive post-harvest loss and packaging methods, even fully mature fruits do not make it to the markets. Labelling and traceability are important aspects of packaging with which fruit producers have to comply with. Integrated marketing that covers appropriate pricing, labelling, packaging and branding fruit (e.g. fresh, nutritious, high quality and exotic) can help capture the growing global market.

3.4 The Vegetable Industry

3.4.1 Introduction

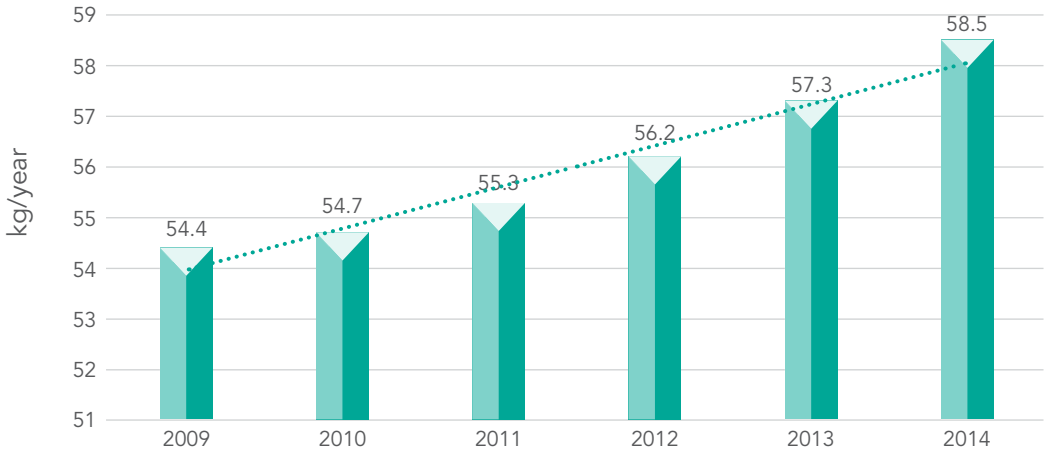
The vegetable industry spans a diverse group of crops. In 2018, this industry accounted for less than 2.5% of Malaysia's total food exports, while the share of vegetable imports (fresh or chilled) in total food imports was nearly 7%.[4] Despite increasing production, Malaysia is still an overall net importer of vegetables because of its failure to meet growing domestic demand. The increasing imports, which are used to fill the domestic supply shortage, has caused Malaysia to run a trade deficit in the vegetable sub-sector. This outflow of cash and influx of imported food has led to food security concerns, since it indicates Malaysia's dependency on imports.

The continued emphasis on the benefits of eating fresh produce may provide opportunities to this industry. Changes in consumer taste and preference, urbanisation, and increasing income have led consumers to understand the importance of good nutrition. Fruits and vegetables, which are excellent sources of vitamins and minerals, are increasingly in demand. This can be reflected through the increase in PCC. Malaysians are eating more vegetables than they did 20 years ago, yet average consumption is still below the recommended intake. The PCC of vegetables increased by about 7.5% from 54.4kg/year in 2009 to 58.5kg/year in 2014 (Figure 5). The five most commonly consumed vegetables are round cabbages, tomatoes, chillies, cucumbers and mustard.

The NAFP predicts that the demand for vegetables will increase from 1.6 million metric tonnes in 2010 to 2.4 million metric tonnes in 2020. With the increase in population and income per capita, consumption per capita is also projected to reach 70kg by 2020. Health awareness is expected to drive the demand for green vegetables higher, and increasing vegan/vegetarian culture is also expected to contribute to growth of demand.

[4] The data on trade of vegetables is not available for Penang.

Figure 5: Domestic Per Capita Consumption of Vegetables, 2009-2014



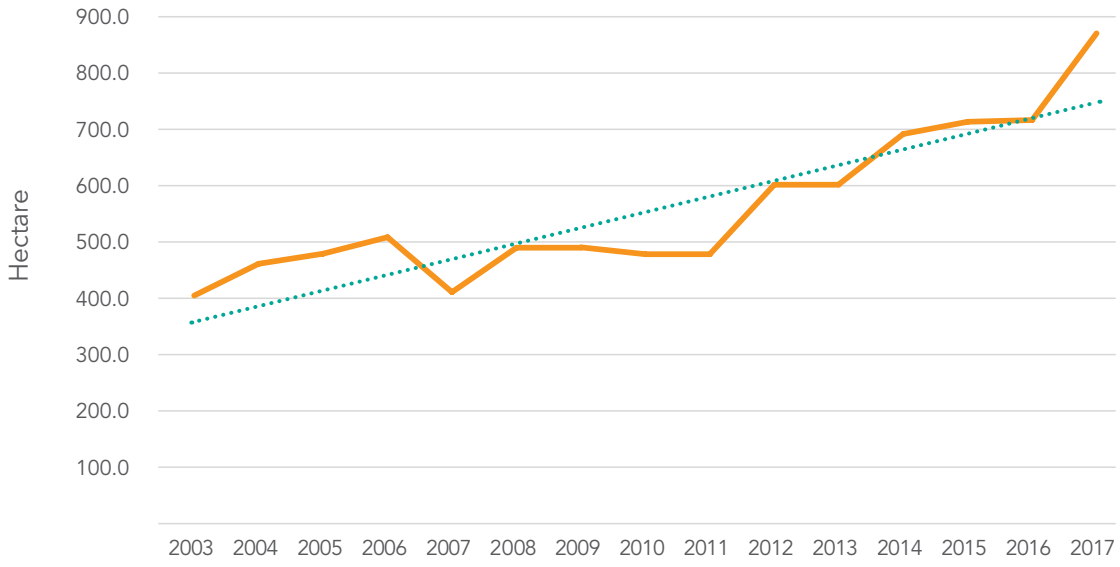
Source: Ministry of Agriculture and Agro-Based Industry, Malaysia

3.4.2 Structure of Production and Supply

Malaysia's crop production is often divided into two categories: commercial crops (i.e. rubber and oil palm), which receive government backing since they contribute significantly to the GDP; and food crops (i.e. vegetables and fruits, with the exception of paddy), which do not receive proper attention. This results in the formation of clusters of well-funded commercial crop producers which utilise modern technology, and numerous less-efficient smallholders. Generally, food production, especially vegetable production, is cultivated on small plots. Vegetable farms take up less than 5% of Penang's total agricultural land. The planted area of vegetables has seen an increase of 115.4% between 2003 and 2017 (Figure 6). This trend suggests that there has been an increased stress on vegetable production.

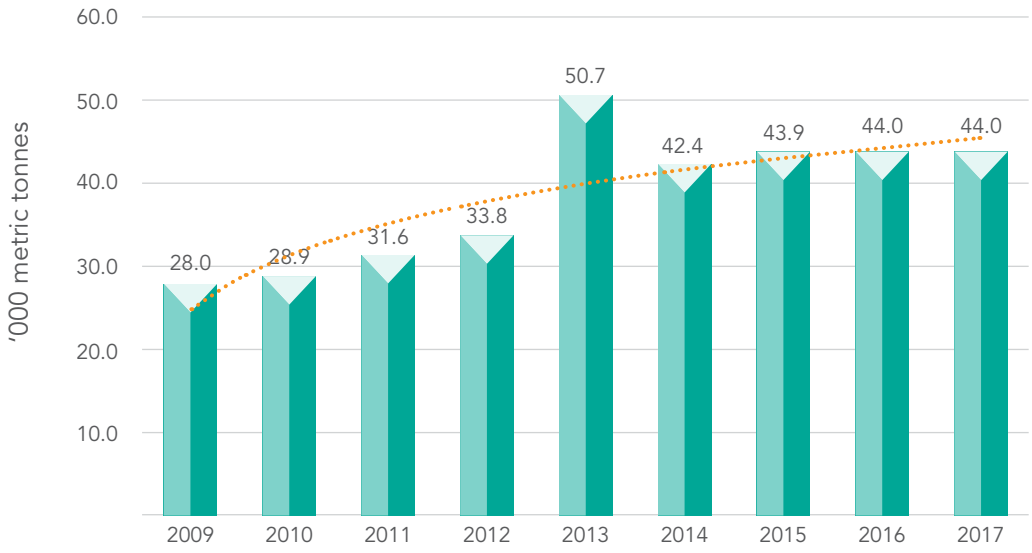
Along with the growing planted area, vegetable production in Penang is also facing an upward trend at the same pace. The 57.2% increase in output from 2009 and 2016 indicates that Penang's vegetable sub-sector is expanding (Figure 7). The increase in farmland and output would lead to a rise in the vegetable sub-sector's SSL. Due to improvements in production management and technology and growth in domestic consumption, vegetable production is expected to continue increasing in the future. Vegetable production is currently centred on Central and North Seberang Perai.

Figure 6: Vegetable Farmland in Penang, 2003-2017



Source: Department of Agriculture, Penang

Figure 7: Vegetable Production in Penang, 2009-2017

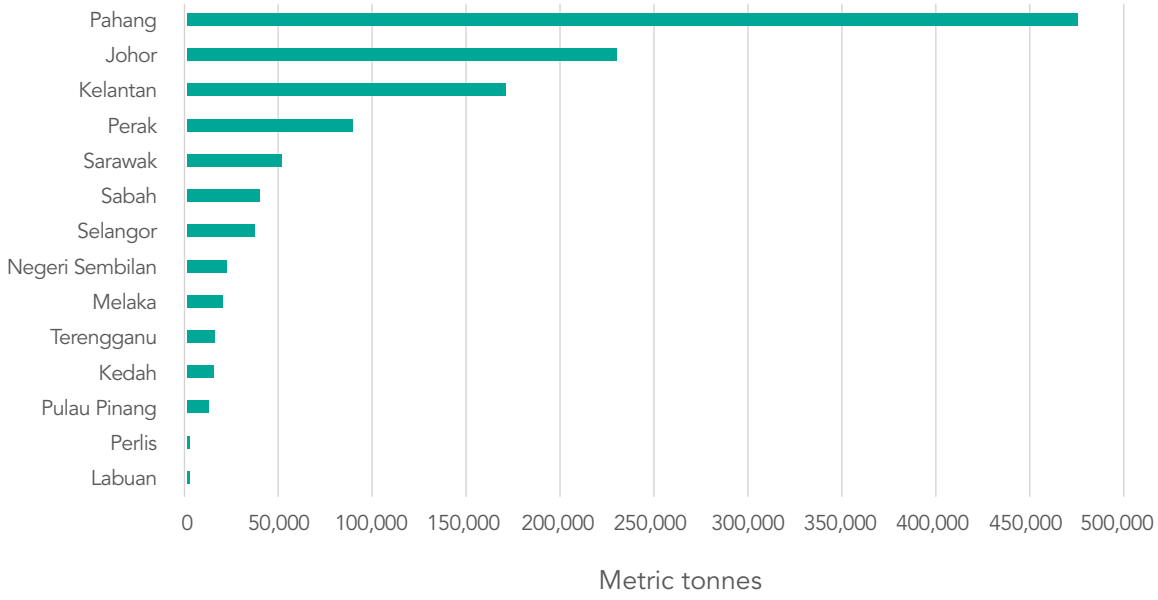


Source: Department of Agriculture, Penang

This expansion of the vegetable sub-sector in recent years is the result of effective government policies. It also means that Penang is taking matters into its own hands as concerns of food security rise. Again, given Malaysia's conducive climate, the increasing vegetable production could make it a major trade commodity in the near future.

The NAFP predicts that domestic production will increase from 0.7 metric tonnes in 2010 to 1.7 metric tonnes in 2020. This rise is caused by the increased planted area and increasing productivity in the vegetable sub-sector. When production is taken as a matrix of comparison, Penang ranks the third-smallest producer of vegetables in the country (Figure 8). This is associated with its land size and planted area. At a national level, Pahang, Johor, Kelantan and Perak lead the production of vegetables.

Figure 8: Vegetable Production by State, 2016



Source: Department of Agriculture, Malaysia

Despite the sub-sector's robust growth, production is still below domestic demand. Most vegetables pass through the middlemen, who are collectors, transporters and/or wholesalers. A small number of farmers supply produce directly to markets or to FAMA. This structural friction could affect the price of vegetables. This fluctuation in price is a result of inelastic supply. Between 2009 and 2017, the vegetable sub-sector experienced an annual inflation rate of 4.6% (Table 3). In fact, most agricultural commodity markets – particularly fresh vegetables – are characterised by a high degree of volatility[5]. Since most agricultural commodities are produced in an open environment which makes them more vulnerable to extreme weather, such as variations in rainfall patterns and temperature, as well as pests and disease, the grower has limited control. It would therefore lead to unforeseen peaks and troughs in supply. In most fresh produce markets, prices rise when crops are damaged and supplies are insufficient, particularly in markets where imports are not immediately available. In addition, demand elasticities are relatively small in regard to price and supply elasticities are also low, at least in the short run. In order to get supply and demand back into balance after a supply shock, prices therefore have to vary rather strongly, particularly if stocks are low.

[5] Volatility refers to variations in agricultural prices over time.

Table 3: Consumer Price Index for Vegetables in Malaysia, 2009-2017

Year	Index	% Change
2009	92.8	-
2010	100.0	7.8
2011	105.3	5.3
2012	104.1	-1.1
2013	109.0	4.7
2014	111.5	2.3
2015	119.6	7.3
2016	127.4	6.5
2017	132.5	4.0

Source: Department of Statistics, Malaysia
Note: 2010 is the base year. Hence, it has a consumer price index of 100.

Although vegetables occupy a relatively small share of the market, organic production represents one of the fastest growing segments of the Penang vegetable sub-sector. In the NAP3 and the NAFP, organic farming has been identified as a niche market opportunity (export opportunity) that can bring high revenue to the country, especially for fruits and vegetables. One of the strategies undertaken by the government was to encourage small-scale farmers to participate in organic farming to increase their income. Furthermore, organic agriculture avoids problems of chemical residue, minimises environmental pollution, reduces food imports while having export potential.

3.4.3 Policies

The NAFP has suggested three methods to tackle the challenges faced by the vegetable industry. This includes increasing the productivity and production of the sub-sector, improving post-harvest management of vegetables and marketing logistics, and strengthening the market for vegetables. The policy plans on increasing productivity by increasing the intensity of crop plantation from 1.8 rounds per year in 2010 to 2.5 rounds by 2020. It also plans on increasing land usage from 30,000 hectares to 36,000 hectares by 2020.

The NAFP plans to increase land usage by developing abandoned land in a project called Taman Kekal Pengeluaran Makanan (TKPM) and advocating for integrated plantation systems through the Federal Land Development Authority (FELDA) and the Federal Land Consolidation and Rehabilitation Authority (FELCRA). The development of abandoned areas will be supervised by the DOA. The policy plans to improve post-harvest management by enforcing farmers' compliance with the 3P Regulation (Pembungkusan, Pelabelan dan Pengedaran, or Packaging, Labelling and Grading) as per FAMA regulations. The regulation aims to improve the efficiency of local produce marketing to retain their competitiveness, maintain the current market share, and expand access to both domestic and international markets in line with global trade changes.

In order to strengthen market share, the NAFP plans to create more incentives for the production of organic vegetables and expanding the implementation of the Malaysian Organic (myOrganic) certification. FAMA has also created pasar tani to train farmers how to retail produce while providing the necessary packaging equipment.

3.4.4 Issues and Challenges

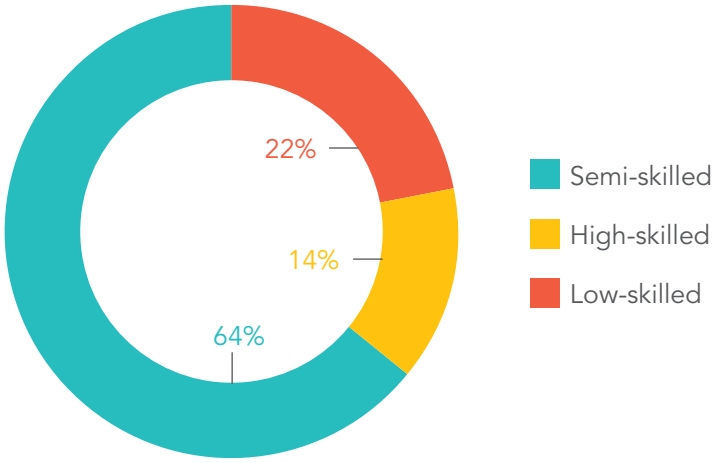
Overall, the agricultural sector in Penang faces three main problems:

i. independent, small-scale farmers who must often work second jobs to supplement their income;
ii. rising consumer demand; and
iii. increased production costs.

Land and labour scarcity, as well as high production costs (e.g. expensive labour and pesticides), are important factors that can adversely affect the production and drive up the costs of local vegetable and fruits.

According to the National Economic Census, in 2015, only 1,445 people working in the agricultural sectors (0.004% of the total workforce in the agricultural sector) have post-graduate qualifications. Around 88% (323,486 people) have SPM qualifications or the equivalent (DOSM, 2016). This is a lack of intellectual contribution to the agricultural sector and its sub-sectors. In Penang, only 221 skilled workers were engaged in agricultural activities (Figure 9). In contrast, there were 1,035 semi-skilled workers (64% of the total workforce) and 366 low-skilled workers. The shortage of skilled labour has had an inevitable effect on the growth of Penang's agricultural sector, although Penang contributes the highest percentage of high-skilled persons engaged in the crops sub-sector compared to the other states (Figure 10). A region that aims to be globally competitive needs to have a highly skilled workforce and knowledge-based industries.

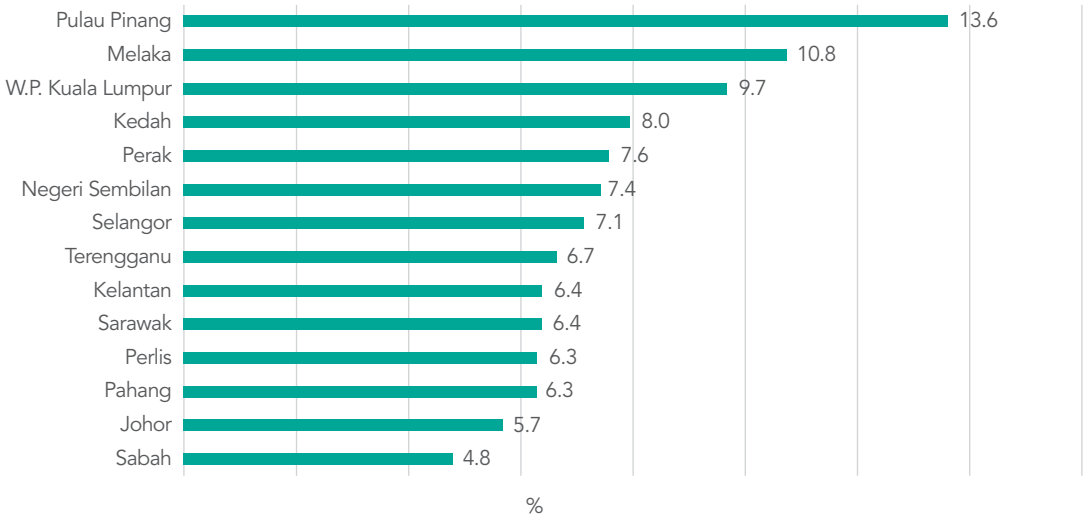
Figure 9: Skill Level of Agricultural Workers in Penang, 2015



Source: Department of Statistics, Malaysia

Note: Calculated based on the total number of workers in December or during the last pay period.

Figure 10: Percentage of High-Skilled Agricultural Workers Nationwide, 2015



Source: Department of Statistics, Malaysia
Note: Calculated based on the total number of workers in December or during the last pay period.

As consumer awareness of organic farming improves, the demand for organic vegetables is likely to increase. Producers must adapt their production methods in order to tap into the resulting growing global and domestic markets. The inelasticity of supply also means that there will not be a stable income for farmers. This problem makes the industry unattractive to the younger generation.

Producers from China and Thailand compete strongly with Penang in the international market. The growth of China's agricultural industry has been spurred by lower production and shipping costs, which domestic producers are unable to compete against. Hence, Chinese produce can dominate major export markets such as Japan, South Korea, Taiwan, Hong Kong and Singapore. Local producers are also hampered by environmental issues such as climate change, a lack of fresh water and the spread of diseases.

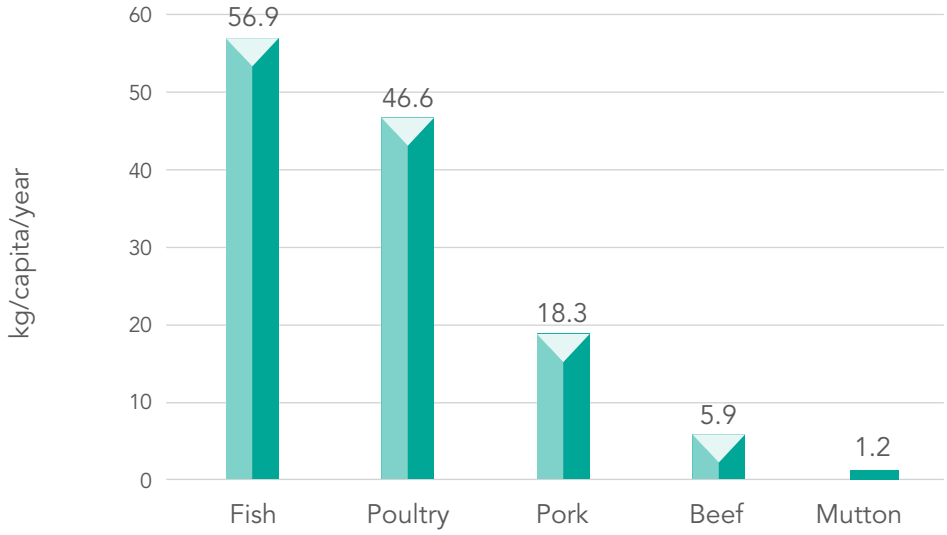
3.5 The Fisheries Industry

3.5.1 Introduction

For many years, the fisheries sub-sector in Penang has been crucial in reducing poverty and achieving food security. Despite representing less than 1% of the national GDP (and only constituting 10.5% of the agriculture sector) (DOSM , 2018), it provides employment for thousands of people, especially those in rural communities. Coastal communities are particularly dependent on fisheries as a source of employment and for 44% of their total animal-sourced protein intake (Figure 11). Therefore, they contribute to food and nutrition security, employment and national economic growth.

An increasing population and an increased consumption of animal protein due to lifestyle changes and rising incomes means that demand for aquatic food products is expected to increase. Production from marine capture fisheries (aka wild fisheries) on the west coast of Peninsular Malaysia are expected to become unreliable because many fish stocks have been overexploited. Therefore, various aquaculture techniques are being explored to increase production. It will likely become an increasingly important sub-sector in the future.

Figure 11: Domestic Per Capita Consumption of Protein, 2014



Source: Department of Statistics, Malaysia.

In 2017, Penang's food fish sub-sector (consisting of marine capture fisheries, aquaculture fisheries and inland fisheries) produced 96,970.4 metric tonnes valued at RM1.4 billion, but domestic demand for fish still outstrips supply. In 2017, the wholesale value of food fish in Penang was the third highest in the country, behind Perak and Kedah. The breakdown of Penang's food fish supply in 2017 is as follows:

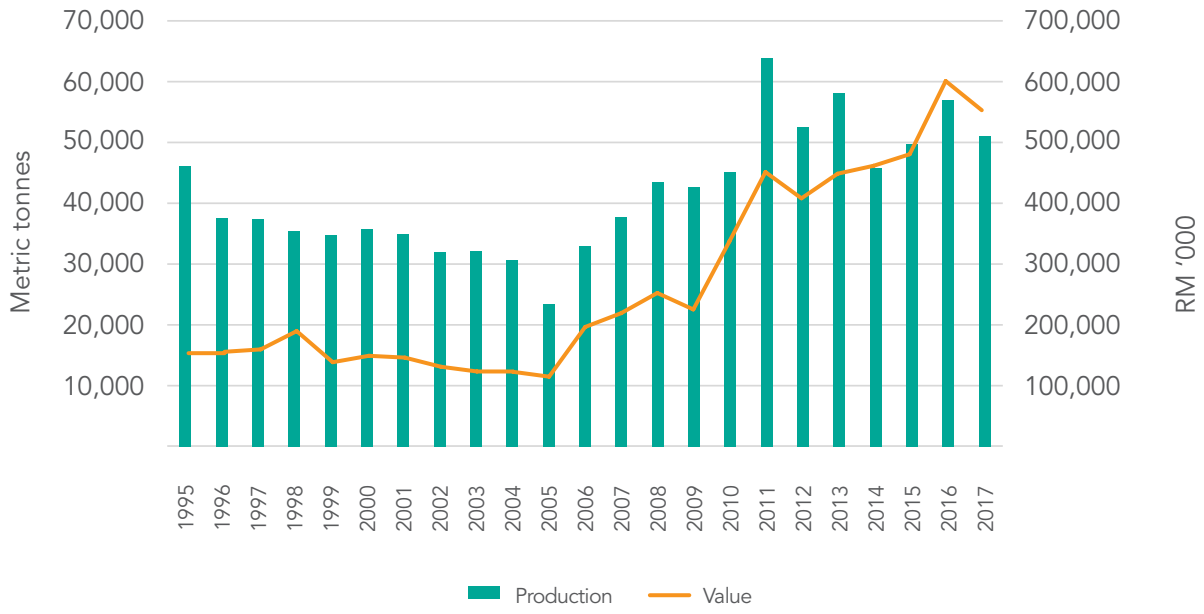
i. Aquaculture provided 47.2% (45,743 metric tonnes valued at RM815.2 million) of the supply;
ii. Marine capture fisheries provided 52.8% (51,185 metric tonnes valued at RM555.2 million); and
iii. Inland fisheries provided 0.04% (42.42 metric tonnes valued at RM827,420).

3.5.2 Marine Capture Fisheries Sub-Sector

According to Figure 12, Penang's marine capture fisheries declined dramatically by about 49% between 1995 and 2005, falling from 46,177 to 23,450 metric tonnes. Despite this decline, the quantity of marine fish landings increased to a high of 63,972 metric tonnes in 2011. 51,185 metric tonnes were reported in 2017. The wholesale value of capture fisheries increased significantly from RM152.6 million in 1995 to RM555.2 million in 2017. The DOF predicts that production will increase by 10% annually until 2020.

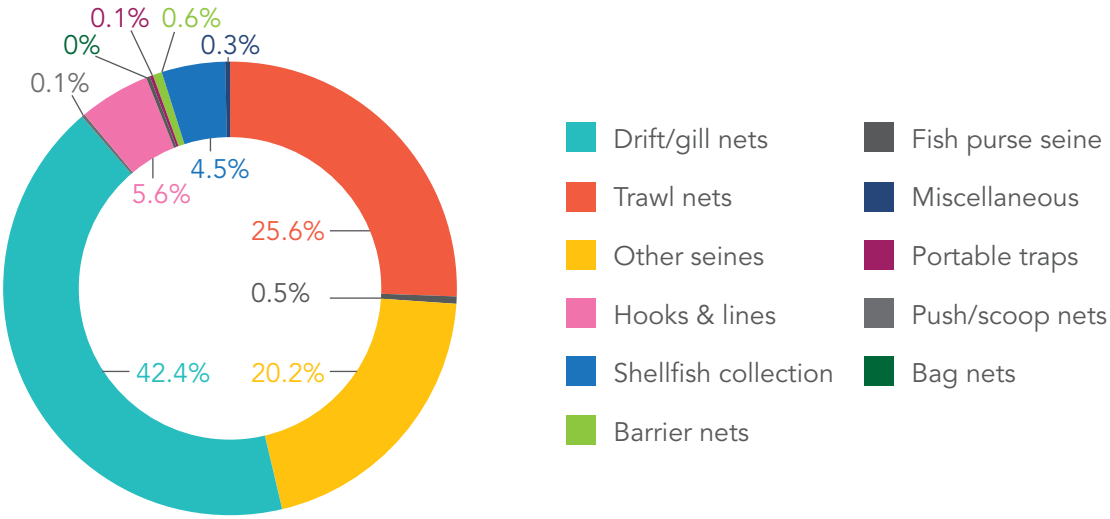
The decline from 1995 to 2005 was attributed to controlling overfishing issue. In the case of west coast of Peninsular Malaysia, overfishing mostly caused by introduction and rapid spread of trawl fishing. Trawls, which are cone-shaped nets, scrape the seabed and catch not just adult fish, but also juveniles, while destroying their breeding or spawning grounds. Eventually, overfishing prompted the government limited the number of fishing vessel licenses. Furthermore, environmental degradation, mostly due to seawater pollution, as well as destruction of mangrove swamps for coastal zone development affected the survival of fry and by extension fish stocks (Chan et al., 2004). In Penang, the greatest contributions to total landings were from drift/gill nets (42.4%) followed by trawl nets (25.6%) (Figure 13).

Figure 12: Penang's Marine Landing Fish Production and Wholesale Value, 1995-2017



Source: Department of Fisheries, Malaysia.

Figure 13: Percentage Catch by Fishing Method, Penang, 2017



Source: Department of Fisheries, Malaysia.

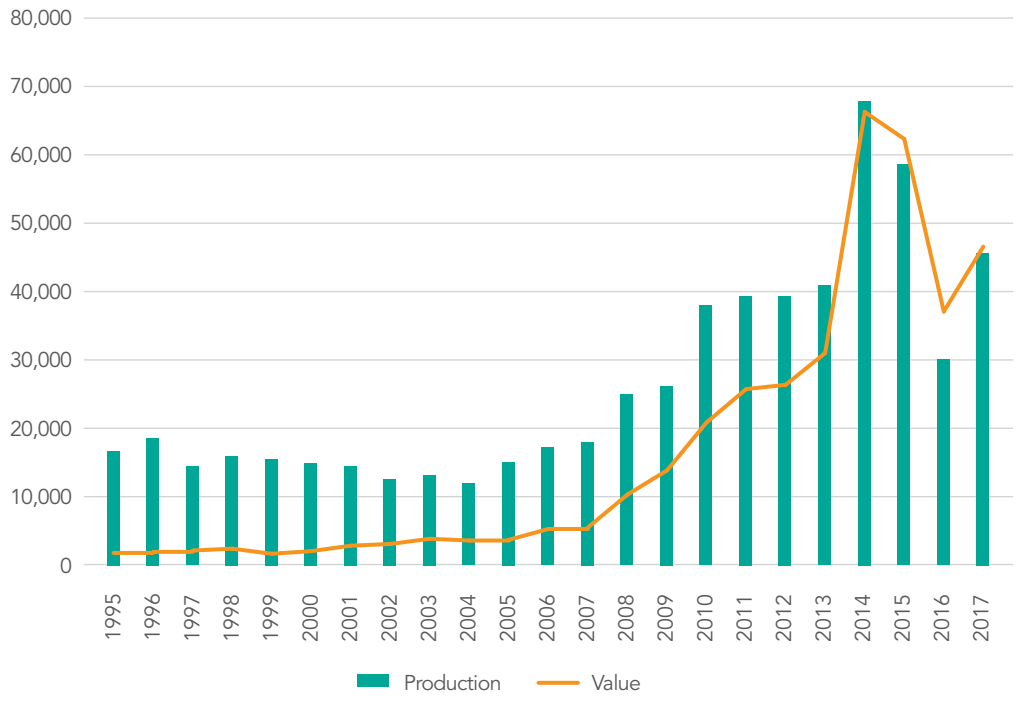
3.5.3 Aquaculture Sub-Sector

Aquaculture, or fish farming, is the cultivation of aquatic animals, including fish, molluscs, crustaceans and aquatic plants, in natural or controlled marine or freshwater environments. Taking overexploitation of natural stocks into consideration, aquaculture is becoming more economically viable as a method to increase local fish production in anticipation of increased demand. In Malaysia, high grade aquaculture products are mostly exported, while the catch from marine landings are sold domestically[6].

From 1995 to 2017, Penang's aquaculture sites, or fish farms, have seen significant growth. On average, annual production has increased by 4.6% while the market value of products has increased by 15.9% each year (Figure 14). Indeed, the percentage contribution of aquaculture to total fish production is increasing, and is expected to continue at a rate of 10% annually until 2020. 2016 was an exception, in which the total aquaculture production in Penang dropped by 55.6%. This was likely caused by disease and the 2015/2016 El Niño phenomenon. In 2017, aquaculture production and its wholesale value increased by 31.3% and 25.6% respectively.

Penang's aquaculture industry can potentially cultivate fish and seafood products for domestic and external consumption. It is already the third largest domestic producer behind Sabah and Perak. Given that aquaculture is the largest contributor to Penang's fisheries sub-sector, it can potentially be the state's main economic driver.

Figure 14: Aquaculture Production and Wholesale Value in Penang, 1995-2017



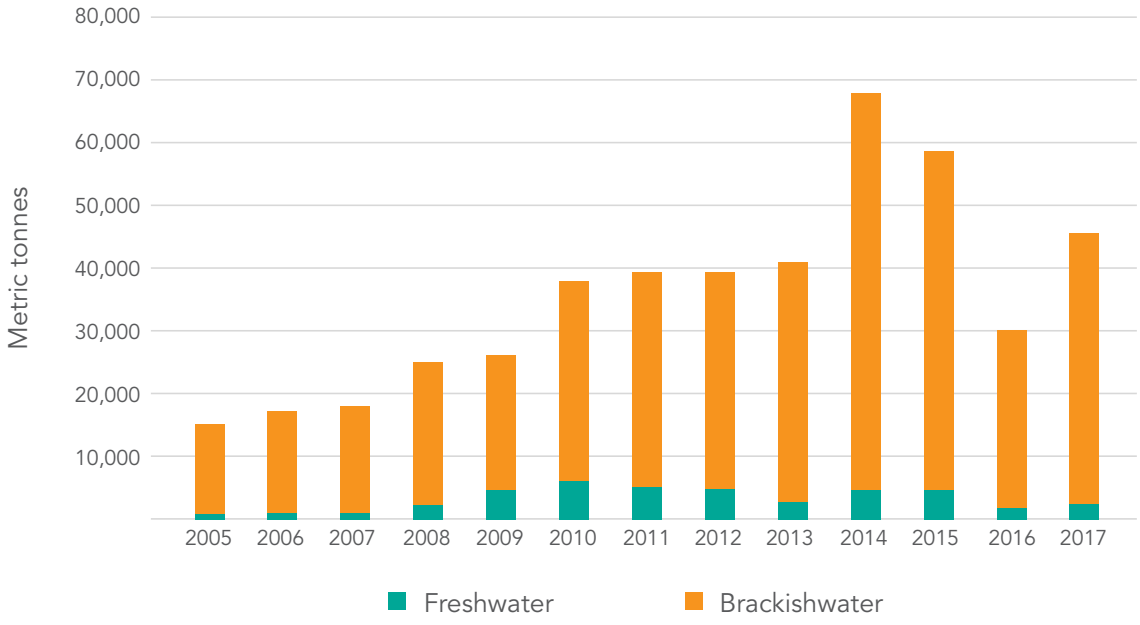
Source: Department of Fisheries, Malaysia.

[6] Data on trade of fish and fishery is not available for Penang.

The aquaculture sub-sector in Penang and Malaysia uses various culture systems and grows diverse types of species. In Penang, freshwater (where animals are cultivated in ponds, cement tanks and canvas tanks) and brackish water (where fish, cockles, mussels and oysters are grown in ponds and cages) culture systems are used. Brackish water systems supplied of Penang's aquaculture products (Figure 15). In 2017, the products of Penang's aquaculture farms had the highest wholesale value in the country. Fisheries from brackish water culture systems contributed 44.6% of the total fish production and nearly 59% of its wholesale value. They are therefore regarded as one of the most economically valuable fisheries in Penang. The primary products were sea bass and snapper, followed by shrimp, cockles and other species, such as grouper and mackerel.

Shrimp culture showed similar trends. From 2011 to 2015, Penang's farmed shrimp had the highest wholesale value in the country, and was the second largest producer of shrimp after Sabah. In 2016, Penang's shrimp aquaculture production dropped significantly by 56.7% compared to 2015, mostly due to disease. However, its wholesale value remained strong, and was the second highest nationwide. But shrimp production and wholesale value declined further by 47.4% and 52.8% respectively in 2017, possibly due to ongoing disease issues (Table 4 and Table 5). Diseases are therefore a threat to sustainable development of the shrimp industry.

Figure 15: Production by Culture System in Penang, 2005-2017



Source: Department of Fisheries, Malaysia.

Indeed, shrimp farming is a high income venture for farmers and has a very high export value, which can be profitable for the state. Since returns from shrimp aquaculture can be forecasted, farmers can earn a higher and more stable income compared to fishing or planting crops such as paddy and oil palm (Kharas et al., 2004). However, unplanned and unsustainable development of shrimp farms has environmental costs, such as the destruction of natural habitats and displacement of traditional livelihoods. Organic aquaculture practices and best management practices would enhance the sustainable development of shrimp aquaculture.

Table 4: National Shrimp Aquaculture Production (Metric Tonnes), 2009-2017

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Perlis	119.5	193.0	87.5	19.0	151.3	65.8	229.9	224.0	293.8
Kedah	2,659.5	2,733.3	2,140.7	1,471.5	2,509.1	2,341.8	1,066.7	1,232.2	1,813.2
Penang	4,906.4	7,463.7	10,975.8	11,299.5	11,556.7	13,429.4	10,477.6	4,323.7	2,273.6
Perak	16,134.4	17,601.4	10,038.0	4,726.8	4,917.1	5,416.0	5,764.2	4,329.6	3,124.8
Selangor	4,819.6	4,951.6	4,451.8	3,507.2	1,717.0	3,178.5	1,793.8	1,132.2	458.9
Negeri Sembilan	1,081.1	1,367.5	1,377.1	971.8	742.8	697.8	353.9	502.4	-
Melaka	138.3	155.6	64.9	69.0	70.1	166.1	133.2	110.8	91.1
Johor	8,715.1	13,326.3	7,276.3	4,274.6	4,332.6	4,451.5	4,385.0	5,244.3	6,918.1
Pahang	307.2	257.1	998.8	1,433.0	3,640.2	3,468.2	2,191.2	3,168.7	4,133.7
Tereng-ganu	443.0	349.8	273.8	564.2	2,195.2	2,835.9	3,352.9	4,031.3	2,064.8
Kelantan	46.5	131.8	136.0	119.0	188.0	240.0	81.3	62.1	55.8
Sarawak	4,701.1	7,499.0	8,473.4	8,848.0	1,757.4	2,002.7	3,866.6	3,083.4	2,787.7
Sabah	8,854.7	13,054.2	14,027.9	11,688.3	11,696.2	18,887.4	14,588.6	1,0041.2	11,632.5

Source: Department of Fisheries, Malaysia.

Table 5: National Wholesale Value of Shrimp Aquaculture Production (in thousands of ringgit), 2009-2017

	2009	2010	2011	2012	2013	2014	2015	2016	2017
Perlis	1,314.5	1,717.3	1,093.5	237.5	1,890.8	964.7	3,329.5	3,709.1	5,860.3
Kedah	28,479.2	28,813.5	22,789.3	17,505.1	33,819.6	43,128.9	18,687.9	21,494.7	31,166.9
Penang	49,771.1	77,286.2	128,215.2	142,994.7	208,342.6	321,236.6	268,970.2	116,371.0	54,967.7
Perak	163,455.2	176,570.9	118,775.1	66,281.0	75,335.8	123,214.9	135,278.5	87,535.2	64,609.8
Selangor	43,966.3	51,699.1	53,329.0	48,516.0	27,197.9	64,894.9	37,469.4	24,117.7	8,272.3
Negeri Sembilan	14,054.3	16,410.2	16,525.4	11,661.1	8,913.7	13,785.3	5,782.2	7,536.0	-
Melaka	1,244.7	1,426.6	1,099.0	2,493.9	1,402.3	3,701.7	3,064.6	2,553.6	2,388.1
Johor	112,279.3	158,160.9	81,063.7	26,477.8	65,793.4	75,142.1	92,345.1	112,438.4	175,622.9
Pahang	3,839.9	3,213.8	12,901.3	18,868.1	47,322.6	68,212.7	40,172.4	71,823.6	103,243.9
Terengganu	4,601.1	3,632.7	2,952.7	6,700.0	38,553.1	58,011.4	75,049.8	62,484.5	50,076.3
Kelantan	310.1	1,317.6	1,360.0	1,190.0	2,054.0	2,820.0	1,317.1	1,744.8	1,458.40
Sarawak	54,063.0	112,485.0	127,100.7	132,720.0	26,361.3	40,054.4	88,932.7	49,335.0	42,905.0
Sabah	106,256.2	156,649.8	168,335.3	140,259.0	187,139.8	321,086.5	248,006.4	190,783.6	232,648.9

Source: Department of Fisheries, Malaysia.

Meanwhile, Penang's large number of natural mangrove mudflats are a suitable breeding area for cockles. Cockle harvesting is therefore considered "mangrove-friendly". Penang is the fourth largest cockle producer in the country, behind Perak, Selangor and Johor. Cockle production in Penang dropped sharply from 7,330.8 metric tonnes in 2014 to 1,632.3 metric tonnes in 2015, and kept decreasing to 1,008.2 and 434.1 metric tonnes in 2016 and 2017 respectively (Figure 16). This was mainly due to poor water quality, disease and fluctuations in water temperature. The decreased supply and high demand increased the price of cockles in major markets in Penang.

Figure 16: Cockle Production in Penang, 2009-2017

Source: Department of Fisheries, Malaysia.

Penang is also a major supplier of oysters, trailing only Sabah and Johor. It is home to Southeast Asia's only commercial oyster hatchery, so there is room for growth. Oyster aquaculture is considered ecologically friendly, and requires no feed, little technology and labour. Therefore, farming oysters can be profitable for low-income traditional fishermen.

It is also important to consider the non-food aquatic sub-sector, such as ornamental fish and aquatic plants. Ornamental fish alone were valued at approximately RM4.4 million in 2017, although its production and wholesale value dropped by 66.1% and 81.3% respectively from the previous year (Table 6). Penang is the third largest producer of ornamental fish in the country after Johor and Perak. The state is world-renown for breeding and exporting different domesticated strains of Discus fish.

Table 6: Production and Wholesale Value of Non-Food Fish in Penang, 2008-2017

Year	Ornamental fish		Aquatic plants	
	Production (Units)	Value (RM	Production (Units)	Value (RM)
2008	310,190	3,110,329.3	138,900	208,350
2009	237,470	2,363,916.7	145,400	218,100
2010	309,350	2,515,003.6	76,640	114,960
2011	392,750	3,224,163.1	102,100	153,150
2012	2,904,710	26,572,471.3	107,000	196,250
2013	2,852,050	24,835,952.8	164,200	246,300
2014	2,898,360	26,432,507.5	201,500	302,250
2015	2,803,732	25,928,835.9	34,900	52,350
2016	2,463,425	23,771,637.4	10,000	15,000
2017	836,223	4,442,008.1	-	-

Source: Department of Fisheries, Malaysia.

3.5.4 Characteristics of Fishermen

Fishing is an important source of income, employment and food security, especially among the poor. The aquaculture sector in Penang may have grown rapidly, but there are still traditional fishermen at work. According to Table 7 and Table 8, the number of people working in the fisheries sub-sector (fishermen and culturists alike) increased by an average of 6.4% annually from 2006 to 2014, especially in capture fisheries. However, the number of fishermen working on licensed fishing vessels dropped nearly 37% by 2017, likely due to restrictions on fishing vessel licenses.

The total number of local fishermen slightly increased by about 0.9% between 2016 and 2017, while the number of foreign workers dropped by approximately 10%. In terms of ethnicity, majority of fishermen in Penang are Malay (56%) and Chinese (39%) (Figure 17).

Table 7: Demographics of Fishermen in Penang, 2006-2017

	Local Fishermen					Foreigners						Grand Total
	Bumiputeras	Chinese	Indians	Others	Total	Thais	Indonesians	Filipino	Vietnamese	Others	Total	
2006	1,412	1,283	58	243	2,996	70	0	-	-	0	70	3,066
2007	1,358	1,405	63	158	2,984	106	80	-	-	23	209	3,193
2008	2,023	1,706	75	-	3,804	122	76	-	-	38	236	4,040
2009	2,882	2015	107	536	5,540	36	146	-	-	354	536	6,076
2010	3,598	1,813	108	-	5,519	52	200	200	-	100	552	6,071
2011	3,404	2,077	38	-	5,519	47	59	-	-	8	114	5,633
2012	3,028	2,300	58	37	5,423	26	81	-	-	18	125	5,548
2013	3,739	2,661	433	-	6,833	52	67	-	41	18	178	7,011
2014	4,391	3,077	446	-	7,914	-	67	-	-	28	95	8,009
2015	3,203	2,175	32	-	5,410	60	63	-	22	12	157	5,567
2016	2,860	1,830	84	-	4,774	54	122	-	-	23	199	4,973
2017	2,786	1,976	51	4	4,817	-	150	-	-	29	179	4,996

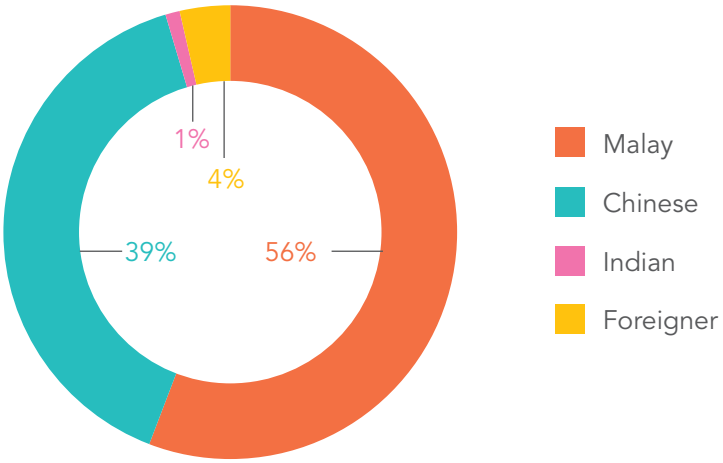
Source: Department of Fisheries, Malaysia.

Table 8: Penang's Culturists by Type, 2006-2017

	Freshwater Culturists	Brackish water culturists	Total number of culturists
2006	134	296	430
2007	135	282	417
2008	88	386	474
2009	55	377	432
2010	89	422	511
2011	152	407	559
2012	152	407	559
2013	97	416	513
2014	107	485	592
2015	106	487	593
2016	78	366	444
2017	76	395	471

Source: Department of Fisheries, Malaysia.

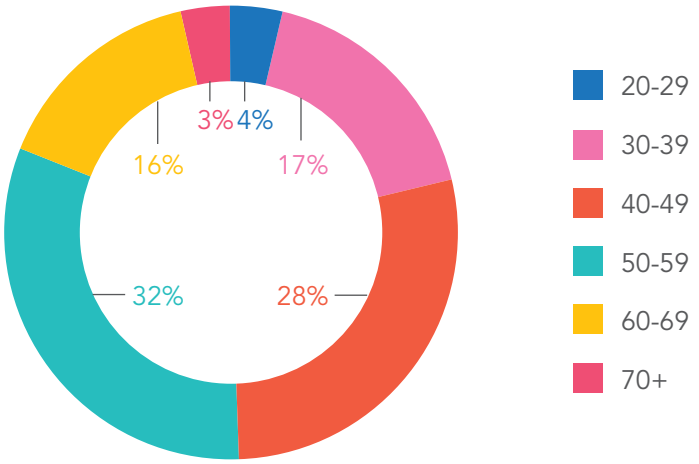
Figure 17: Ethnicities of Penang's Fishermen, 2017



Source: Department of Fisheries, Malaysia.

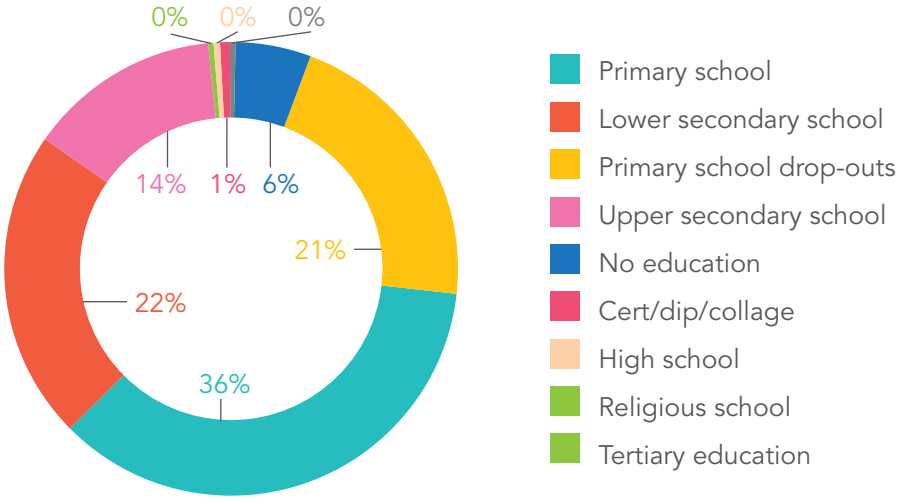
Based on the latest Fishermen's Socio-Economy and Household Data at the time of writing, in 2007, nearly 20% of fishermen in Penang were over 60 years of age (LKIM , n.d.) (Figure 18). Most fishermen were only educated up to a primary and secondary school level (Figure 19).

Figure 18: Age Ranges of Penang's Fishermen, 2007



Source: Fisheries Development Authority of Malaysia.

Figure 19: Educational Levels of Penang's Fishermen, 2007

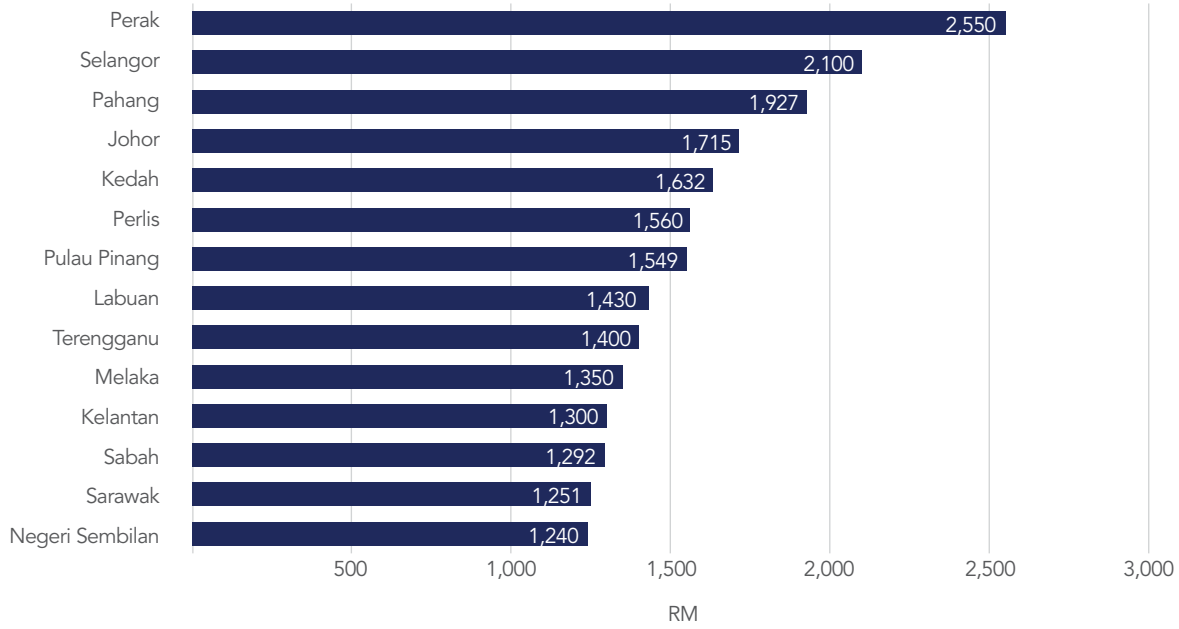


Source: Fisheries Development Authority of Malaysia.

Fishing communities normally have unsatisfactory living conditions, low levels of education, and poor access to services (e.g. schools and healthcare) and infrastructure (e.g. roads and markets). Their access to fishing grounds may not be secure, and alternative employment opportunities are limited. Factors such as low income, age, education, health and access to basic amenities must be considered when investigating poverty among these communities.

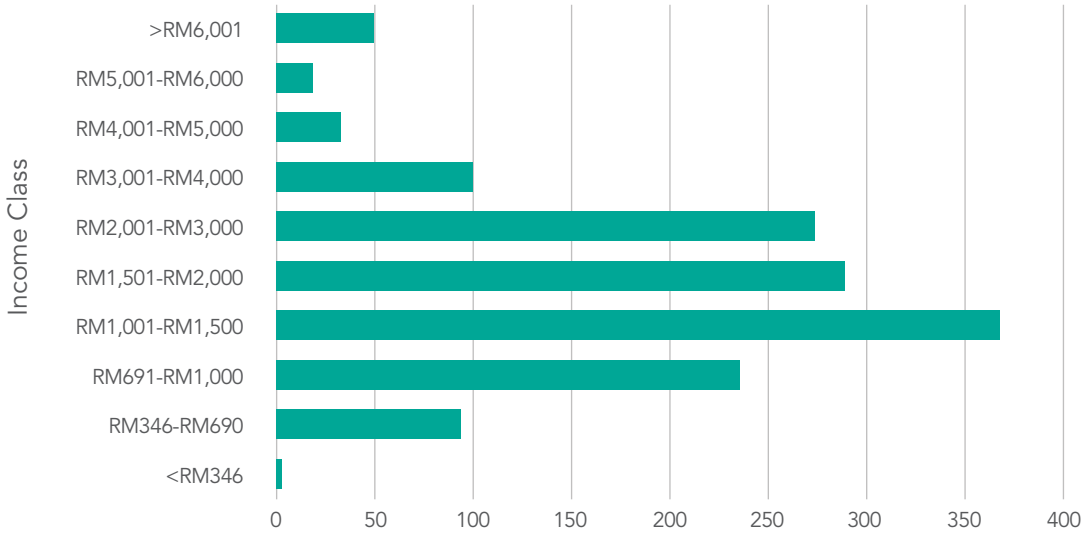
In 2007, the average fisherman's monthly income was RM1,549, and Penang's fishermen ranked seventh nationwide (Figure 20 and Figure 21). The average household income was RM2,589, less than the national average household income of fishermen (RM 2,640). Many households fell below the poverty line—333 households (23%) had a monthly average income of less than RM1,000, with 97 of them (7%) earning less than RM700.

Figure 20: Average Monthly Income of Fishermen, 2007



Source: Fisheries Development Authority of Malaysia.

Figure 21: Average Monthly Income of Fishermen in Penang, 2007



Source: Fisheries Development Authority of Malaysia.

3.5.5 Issues and Challenges

Despite the current successes witnessed by fisheries, especially the aquaculture sub-sector, there are many challenges.

High operating costs are a major issue. Fish farms are heavily dependent on imported feed, which is proving expensive. Pollution and low water quality has increased disease outbreaks in fish farms, thus diminishing production. The dramatic decrease in the supply of cockles after 2015 is a sobering example.

Climate change has led to unpredictable natural conditions, such as the damaging El Niño phenomenon of 2015, which in turn influences the quality and quantity of aquaculture production. Some effects include fluctuations in water temperature, annual rainfall and the unpredictable shift from rainy to dry seasons, which in turn affects the physiological, ecological, and operational aspects of aquaculture activities (Handisyde et al., 2004). Pond aquaculture is sensitive to changes in temperature and rainfall patterns, with shrimp production being particularly vulnerable.

Fish stocks on the west coast of peninsular Malaysia are stressed and overexploited, despite recovery in recent years. Unsustainable fishing practices such as gillnetting and trawling are of primary concern and must be replaced by more sustainable methods. While aquaculture may solve the overexploitation of natural stocks and the destruction of marine habitats, some forms of aquaculture may cause ecological damage and water pollution. High-value species are often favoured, which tend not to be environmentally sustainable. For instance, intensive shrimp farming may damage mangrove ecosystems. The construction of ponds and infrastructure can lead to loss of mangrove habitat, productivity, biodiversity and ecological functions. The ability of mangroves to protect coastal regions may be impaired, and therefore results in erosion, saltwater intrusion and interference with hydrology. There is a socio-economic aspect too: local communities may be marginalised after facing restricted access to the mangroves, resulting in the loss of livelihoods and food (Ashton , 2008). A compromise is for the management to involve local communities in planning and implementation of shrimp farming. The critical challenge is to find sustainable ways to produce more shrimp or fish without negative environmental or social impacts.

Then there is the labour shortage. Since the industrialisation policy was implemented, most of this sub-sector's labour force, especially rural youth, migrated to the more profitable industrial sector. Hence, there is a reliance on foreign workers, which also leads to a loss in foreign exchange. By narrowing the wage gap between aquaculture and other economic sectors, such as manufacturing, this shortage may be avoided. One possibility is the expansion of agro-based industries in rural areas, thus providing employment for younger generations.

3.6 The Livestock Industry

3.6.1 Introduction

The livestock sub-sector is an integral component of the agricultural sector in Malaysia, since it provides gainful employment and is the largest source of protein for Malaysians. In 2017, the livestock industry in Malaysia made up 11.4% of the of the agriculture sector's contribution to the GDP, 0.3% less than the previous year. The livestock sub-sector has grown gradually over the years, although it has been a challenging industry to work in. 31.8% of farmers have left the industry since 2014, leaving only 1,390 livestock breeders in Penang by 2018 (Table 9). Oddly, the number of livestock increased slightly from 13.2 million to 13.5 million by 2018 (Table 10).

Table 9: Penang's Livestock Farmers by Type, 2010-2018

Commodity	2010	2011	2012	2013	2014	2015	2016	2017	2018
Cow	958	887	458	843	870	803	485	470	502
Buffalo	40	38	38	40	43	43	44	39	35
Goat	315	299	329	356	436	372	345	368	333
Sheep	34	32	56	71	69	66	64	55	52
Pig	202	202	208	203	188	189	183	174	167
Chicken	382	408	352	399	380	386	334	324	281
Duck	47	99	56	46	53	52	38	30	20
Total	1,978	1,965	1,497	1,958	2,039	1,911	1,493	1,460	1,390

Source: Department of Veterinary Services, Penang.

Table 10: Penang's Livestock Population, 2010-2018

Commodity	2010	2011	2012	2013	2014	2015	2016	2017	2018
Cow	14,027	13,426	22,653	14,320	16,091	14,766	11,689	11,642	17,633
Buffalo	399	371	325	560	566	601	592	574	622
Goat	11,838	11,098	10,561	12,413	11,005	8,854	8,779	10,215	8,686
Sheep	818	881	1,576	1,766	1,540	1,880	1,628	2,757	2,634
Pig	324,785	324,737	319,502	330,840	311,791	294,429	285,755	317,897	357,243
Chicken	12,608,530	12,557,728	12,156,485	11,989,285	12,399,222	12,475,540	12,539,480	10,739,513	12,802,065
Duck	480,374	494,217	2,139,461	783,003	485,033	485,058	460,510	235,033	318, 200
Total	13,440,771	13,402,458	14,650,563	13,132,187	13,225,248	13,281,128	13,308,433	11,317,631	13,507,083

Source: Department of Veterinary Services, Penang.

Combined, poultry, pork and ducks make up a vast proportion of livestock. In general, the industry has experienced huge increases in the past seven years, as a result of economic and population growth, but sub-sectors such as the production of fresh milk and goat/sheep meat are declining (Table 11). Animal products, especially fresh milk, cow/buffalo meat as well as goat/sheep meat, are projected to be inadequate to meet the domestic demand in the future (Table 12 and Table 13).

Table 11: Penang's Livestock Production, 2010-2018

Commodity	2010	2011	2012	2013	2014	2015	2016	2017	2018
Meat (metric tonnes)									
Cow, Buffalo	927.1	864.4	1,662.2	1,648.6	4,328.0	3,218.4	2,792.3	2,891.6	4,990.7
Goat, Sheep	21.7	18.9	108.5	196.9	257.0	222.6	205.1	249.1	409.0
Pig	15,351.5	11,183.7	24,339.7	31,457.9	33,439.6	31,577.5	30,647.2	31,471.8	35,367.0
Chicken, Duck	56,162.4	56,724.3	79,073.8	75,693.2	71,166.3	69,296.0	69,812.3	69,086.8	81,935.0
Egg (millions)									
Chicken, Duck	427.7	340.6	351.3	310.9	335.6	312.3	309.7	235.6	245.6
Milk (litre)									
Fresh Milk	455,440	330,000	455,440	723,400	891,672	589,888	689,980	589,888	564,350

Source: Department of Veterinary Services, Penang.

Table 12: Projected Output of Penang's Livestock Products

Commodity	11M		Growth rate	12MP		Average growth rate
	2019	2020	(2019-2020	2021	2025	(2021-2025)
Meat ('000 metric tonnes)						
Cow, Buffalo	5.1	5.2	2.0%	5.3	5.7	2.0%
Goat, Sheep	0.4	0.4	2.0%	0.4	0.5	2.0%
Pig	35.7	36.1	1.0%	36.4	37.9	1.0%
Chicken, Duck	83.6	85.3	2.0%	87.0	93.9	2.0%
Egg (millions)						
Chicken, Duck	250.5	255.5	2.0%	260.6	281.5	2.0%
Milk (millions of litres)						
Fresh Milk	0.6	0.6	2.0%	0.6	0.6	2.0%

Source: Department of Veterinary Services, Penang.

Table 13: Projected Demand for Penang Livestock Products

Commodity	11MP		Growth rate	12MP		Average growth rate
	2019	2020	(2019-2020)	2021	2025	(2021-2025)
Meat ('000 metric tonnes)						
Cow, Buffalo	13.6	14.1	3.0%	14.5	16.2	3.0%
Goat, Sheep	1.7	1.8	3.0%	1.8	2.0	3.0%
Pig	12.5	12.9	3.0%	13.3	14.9	3.0%
Chicken, Duck	64.8	66.7	3.0%	68.7	77.0	3.0%
Egg (millions)						
Chicken, Duck	414.4	426.9	3.0%	439.7	491.4	3.0%
Milk (millions of litre)						
Fresh Milk	54.5	56.2	3.0%	57.8	64.8	3.0%

Source: Department of Veterinary Services, Penang.

The livestock sub-sector must improve to meet the drastically increasing demand for animal products (DVS, 2013). Some strategies have already been implemented to increase production and productivity. Penang's DVS has provided aid such as infrastructure upgrades (e.g. stables for ruminants), and farming equipment to farmers and livestock breeders. It is divided into two main categories:

i.Ruminants such as cattle, sheep, goats and buffalo; and
ii.Non-ruminants, such as chickens, ducks and pigs.

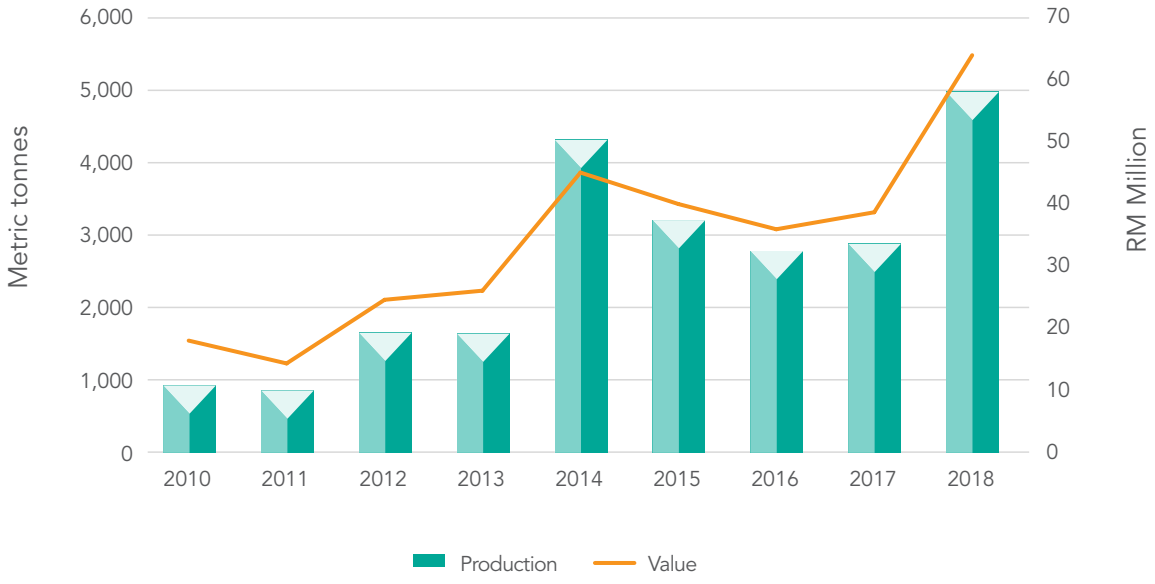
3.6.2 Ruminants

Ruminants are a source of high-quality protein for the population and serve as raw materials for the meat processing industry.

3.6.2.1 Beef/Buffalo

Beef is produced from beef cattle, culled dairy cattle and buffaloes. Production in Penang has risen by 438% from 2010 to 2018, growing from 927 to 4,990.7 metric tonnes. Its value has also increased by nearly 250.7% (Figure 22). Despite this, the incremental increase in demand for beef outstrips production. The consumption of beef is increasing because of a prosperous middle class, which has a greater purchasing power and a demand for higher food quality (Gallet , 2010). By the year 2025, the demand for cow/buffalo meat is expected to increase by 3% on average, while production is expected to increase by only 2%.

Figure 22: Production and Wholesale Value of Beef/Buffalo in Penang, 2010-2018



Source: Department of Veterinary Services, Penang.

This enormous gap between supply and demand might explain the 37.7% SSL of the beef/buffalo sub-sector in 2018 (Table 14). For the moment, production is mostly controlled by smallholders (primarily farmers or fishermen) who see cow breeding as a supplementary source of income. On a national level, Malaysia has been forced to fill the gap by importing beef of varying quality and price from India, Australia and New Zealand (Ariff et al., 2015).

Table 14: Percentage Self-Sufficiency Levels of Livestock Products in Penang, 2012-2018

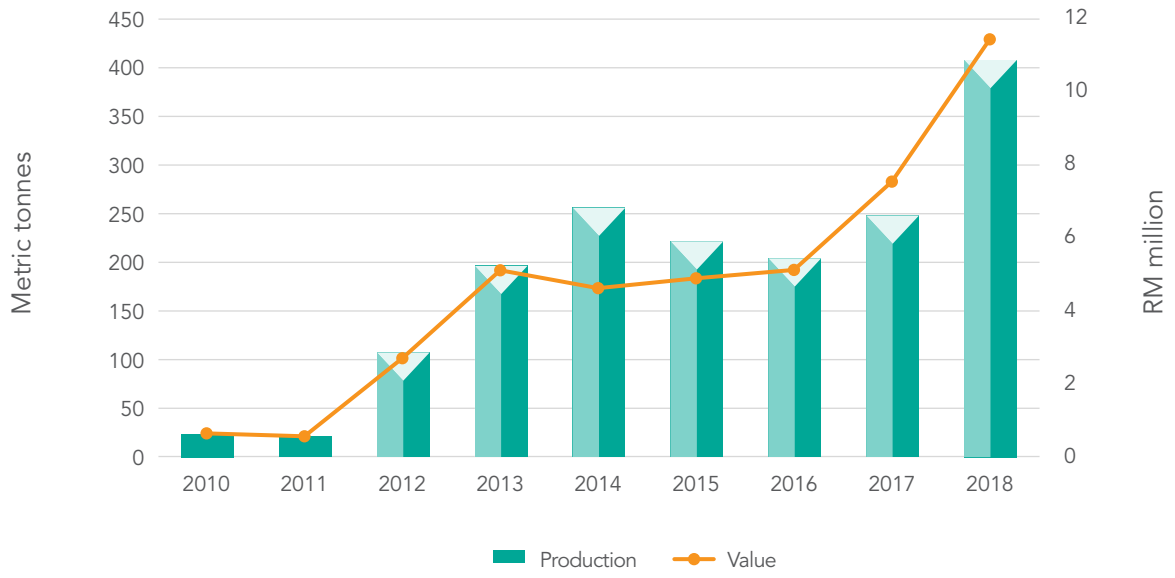
Commodity	2012	2013	2014	2015	2016	2017	2018	Average SSL (2012-2018)
Cow/Buffalo meat	21.9	21.0	53.6	36.3	32.7	22.3	37.7	32.2
Goat/Sheep meat	8.5	15.0	18.9	14.9	14.1	15.3	24.7	15.9
Pig meat	211.7	270.4	284.2	265.8	254.7	263.9	290.8	263.1
Chicken/Duck meat	150.5	142.0	131.5	118.9	123.9	112.0	130.3	129.9
Egg	98.1	84.7	89.2	76.0	78.2	60.5	61.0	78.2
Fresh milk	0.6	1.0	1.2	0.9	0.8	1.1	1.2	1.0

Source: Department of Veterinary Services, Penang.

3.6.2.2 Goat/Sheep

This small ruminant industry in Penang and Malaysia is still in its infancy. Despite experiencing an extensive growth in goat/sheep meat production from 21.7 to 409 metric tonnes between 2010 and 2018 (Figure 23), the total production is still well below the projected demand of 1,700 metric tonnes. Given the Penang State Government expects an average annual growth rate of 2% from 2019 to 2025, drastic measures need to be taken to revamp this industry.

Figure 23: Production and Wholesale Value of Goat/Sheep Meat in Penang, 2010-2018



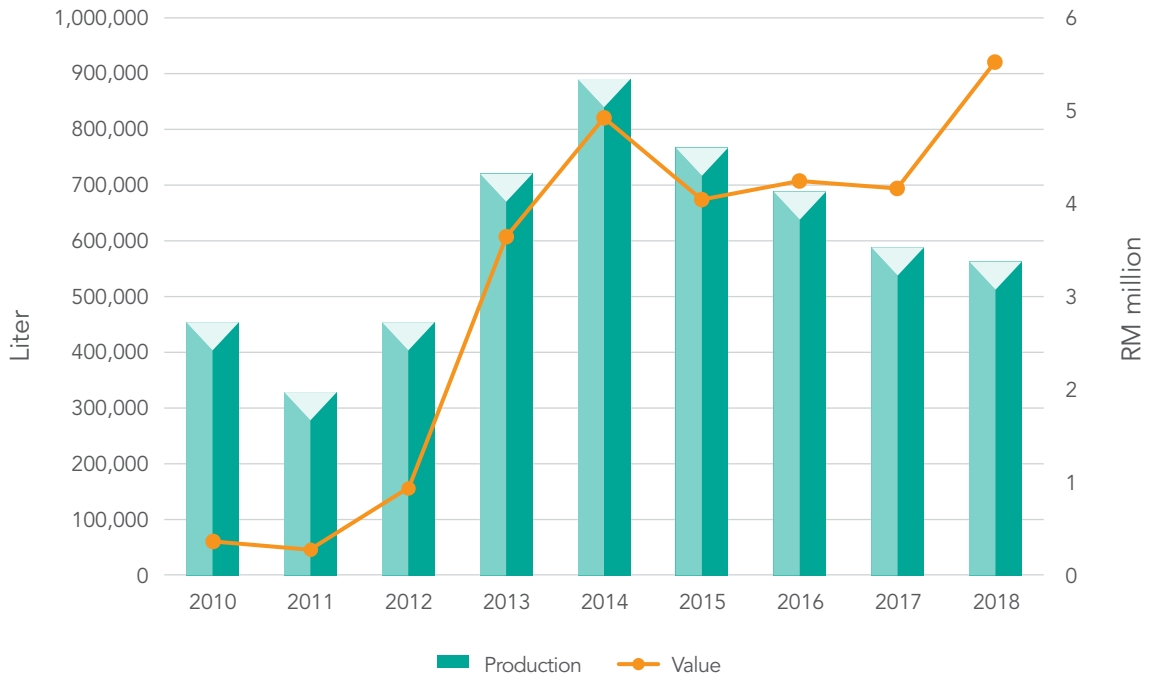
Source: Department of Veterinary Services, Penang.

In 2018, the goat/sheep industry of Penang has the lowest SSL (24.7%) when compared with other commodities such as beef (37.7%), chicken (130.3%), pork (290.8%) and eggs (61.0%) (Table 14). This is often due to the lack of entrepreneurship and government intervention in the sub-sector. For now, goat and sheep are imported from Australia, New Zealand and South Africa. The integration of sheep with primary crops has also garnered interest from the estate sector and this may help to increase the goat/sheep count soon (Arshad et al., 2007).

3.6.2.3 Fresh Milk

The fresh milk industry in Penang is often not a focus of the government and policy makers. Between 2010 and 2018, the production and wholesale value of fresh milk increased dramatically by 23.9% and 1,517.6% respectively (Figure 24). In 2025, projected fresh milk output (0.6 million litres) is still expected to trail behind the demand for fresh milk (64.8 million litres). This is probably why the SSL in fresh milk industry was only 1.2% in 2018. That year, 0.6 million litres were produced although the demand was expected to be 52.9 million litres. Increasing awareness about the nutritional benefits of consuming fresh milk paired and a growing preference for dairy products has fuelled the rise in demand.

Figure 24: Production and Wholesale Value of Fresh Milk in Penang, 2010-2018



Source: Department of Veterinary Services, Penang.

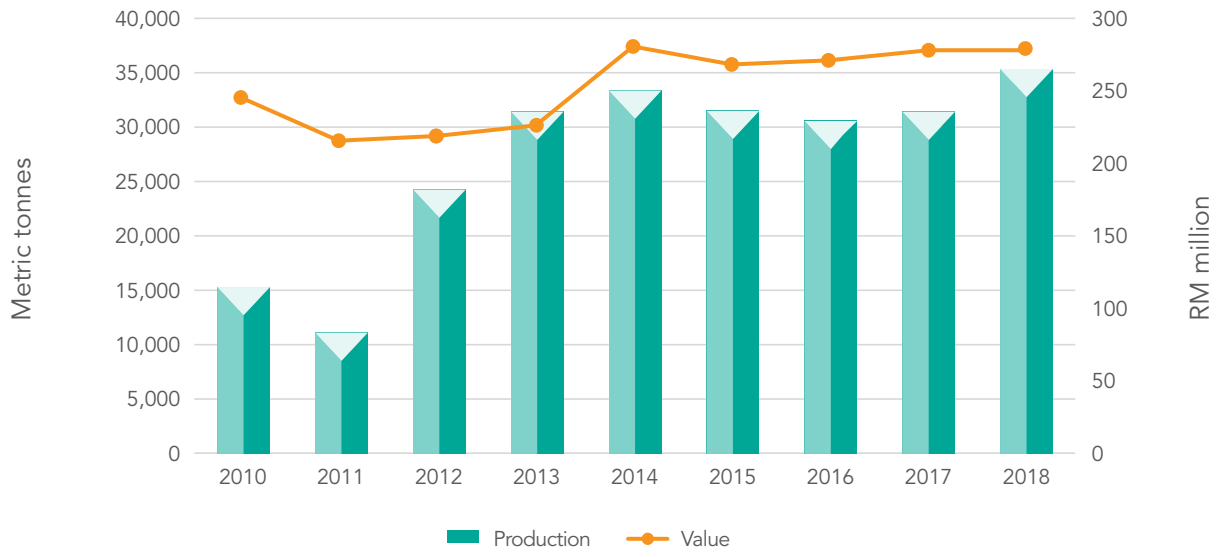
3.6.3 Non-Ruminants

3.6.3.1 Pork

The production of pork in Penang and Malaysia has always been above domestic demand. Over the past eight years, the production and wholesale value of pork increased by 130.4% and 13.8%, respectively (Figure 25). In 2018, 35,367 metric tonnes of pork were produced, thus achieving a SSL of 290.8%. The pork industry is the most self-sufficient livestock commodity in Penang. By the year 2025, the pork meat output is expected to reach 37,900 metric tonnes while demand grows to 14,900 metric tonnes.

The significant SSL allows Penang to be a net exporter of pork, mostly to Singapore. Despite the comfortable situation, the outbreak of diseases such the Nipah virus in 1999 has constantly been a threat. Breeding may also lead to adverse environmental effects. Therefore, the DVS encourages producers to implement the Modern Pig Farming System, where pigs are kept in closed house systems and effluent is not discharged into public waterways.

Figure 25: Production and Wholesale Value of Pork in Penang, 2010-2018



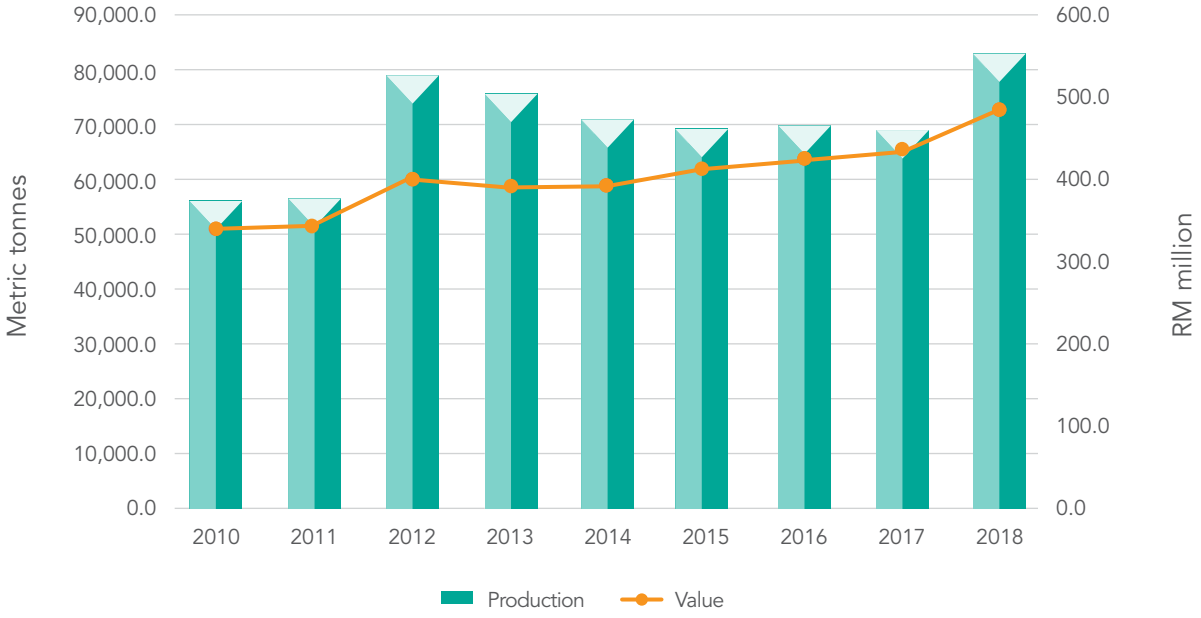
Source: Department of Veterinary Services, Penang.

3.6.3.2 Chicken/Duck

In 2018, the chicken/duck production and wholesale value in Penang increased by 45.9% and 42.4% respectively compared to 2010 (Figure 26). The growth of poultry meat production has been steady between 2012 and 2018, with minor fluctuations. In 2018, the poultry meat had an SSL of 130.3%, thus meeting domestic demand.

The poultry sub-sector has grown significantly in the last few decades into a complex commercial industry. Improvements include the import of hybrid birds, improved nutrition, better feed conversion rate, shorter maturity period and a decrease in mortality rate (Arshad et al., 2007). An integrated production system has been a vital implementation in the last two decades. Although duck meat production is significantly lower, it is still sustainable due to lower demand.

Figure 26: Production and Wholesale Value of Chicken/Duck in Penang, 2010-2018

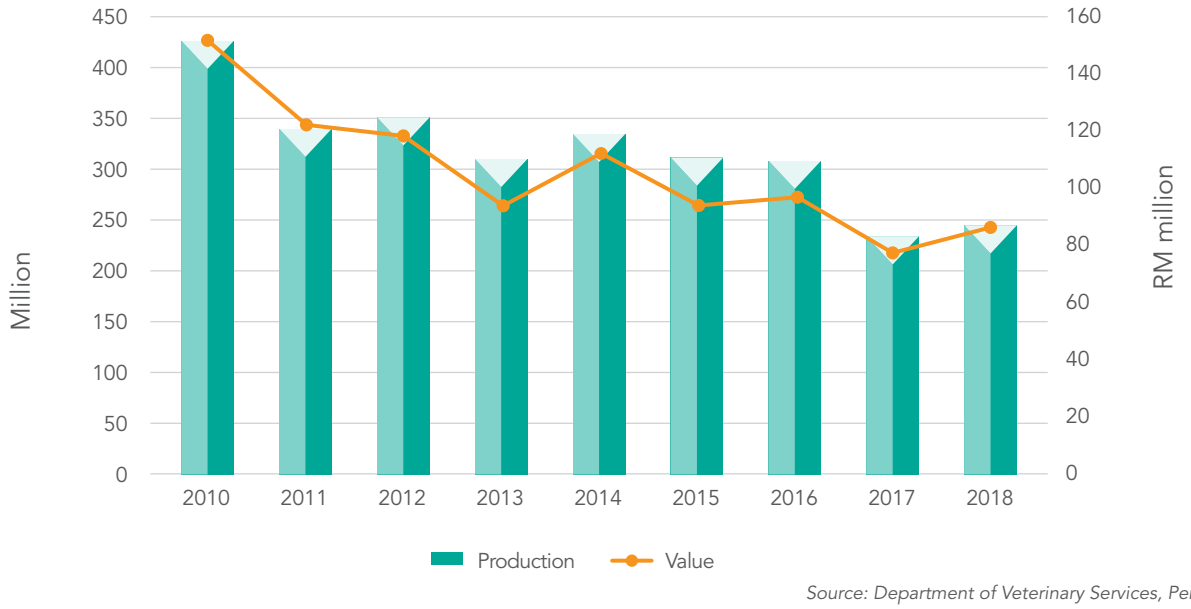


Source: Department of Veterinary Services, Penang.

3.6.3.3 Eggs

Although the Malaysian egg industry has been self-sustainable since 1982, Penang has been struggling to satisfy its domestic demand. As illustrated in Figure 27, the production and wholesale value of eggs has dropped significantly by 42.6% and 42.8% between 2010 and 2018. The increased cost of production is a huge factor, fuelled by the rising price of chicken feed. Naturally, the SSL of the egg industry has decreased. By 2018, its SSL dropped to 61% from 98.1% in 2012. by 2025, Penang's production is only expected to be 281.5 million eggs, versus a demand of 491.4 million eggs.

Figure 27: Production and Wholesale Value of Eggs in Penang, 2010-2018



Source: Department of Veterinary Services, Penang.
Note: Eggs are laid by chickens and ducks.

The growth of both pork and poultry sub-sectors has required an increase in feed import since domestic feed production is insufficient. Meanwhile, major players in the poultry sub-sector are converting conventional breeding systems to closed house systems. This is because the closed house system offers better disease control (hence a decreased mortality rate) and better output quality.

3.6.4 Issues and Challenges

Over the last decade, rapid economic and population growth in Malaysia and Penang led to an increase in the demand for livestock products. While non-ruminant sub-sectors (poultry and pig) have successfully kept up, the ruminant sub-sector failed to do so. The non-ruminant sub-sector is marked by well-developed technology and private capital, in contrast to the ruminant sub-sector.

Both the ruminant and non-ruminant sub-sectors suffer from the price of imported feed. It can be as much as 50% to 60% of the total cost of production. Due to insufficient domestic feed production, the sub-sector is vulnerable to disruptions such as currency crises. There is also a lack of suitable land, which the state can resolve by protecting land gazetted for agriculture and livestock breeding.

To meet the future consumer demand, the state plans to maintain the current level of self-sufficiency for pork and poultry production, and to increase the SSL of eggs to 100%. The state is also planning to enhance the production of cow/buffalo, goat/sheep and dairy products to achieve 50% SSL by 2025. Hence, R&D is required. As stated in the NAFP, several recurring problems, which have yet to be resolved, include the:

i. lack of land;
ii. high feed costs;
iii. relatively cheaper imports;
iv. lack of private sector involvement; and
v. low number of quality breeds, expertise and workforce.

One solution could be increased cooperation between researchers and extension workers (aka agricultural consultants)[7] with farmers. Even smallholders, who may initially be reluctant to introduce modern technology on their farms, should be able to apply new technology after receiving training and advice from extension workers. Farm organisations can serve as an efficient exchange of knowledge. Modern technology and large-scale breeding activities can improve domestic production. There is also a problem of ownership: most farm owners see the livestock industry as a source of side income and thus rent out their breeding equipment to smallholders instead. Naturally, there is a lack of incentive to change things, thus explaining the technological lag experienced by the ruminant sub-sector.

Environmental issues are a particular concern for non-ruminants. Pollution and foul smells often emanate from poultry and pig farms, while waste needs to be handled effectively. Intensive breeding systems (i.e. closed farming systems) can be a useful solution in Penang, since they require little land while being more productive, in addition to emitting lower pollution levels and odours. Although the state government has already started discussing the closed farming system with farmers, and to date only about 10% to 15% of farmers are applying this system, including CAB Cakaran Corporation Berhad.

[7] Extension worker is an important link between research organisations. and farmers.

3.7 Agrotourism

The concept of agrotourism is related to ecotourism, which encourages visitors to experience nature first-hand (Mansor et al, 2015). Also called agritourism or farm-based tourism, it is a growing sub-sector. Visits to orchards and animal farms, research centres and homestays are popular agrotourism options in Malaysia and Penang. In fact, both the agricultural and tourism industries can collaborate to further develop this sub-sector. Agrotourism can generate employment and additional income for the workforce, especially for farmers in rural areas, or those suffering from a lack of land. There is also a cultural aspect at play, since the country's roots and traditions can be discussed too. Forgotten traditions or folk knowledge can be revived for the benefit of both locals and tourists. This is not to mention improved infrastructure for these rural communities. Through the Eighth Malaysian Plan, the government encouraged farmers to participate in the agrotourism industry. Despite being a fertile state with massive potential, this effort was somewhat anaemic in Penang. However, there are some exceptions, such as Teluk Bahang, Aman Island and Batu Maung. Activities carried out in these places include processing belacan, breeding fish in cages, leisure fishing and visits to orchards.

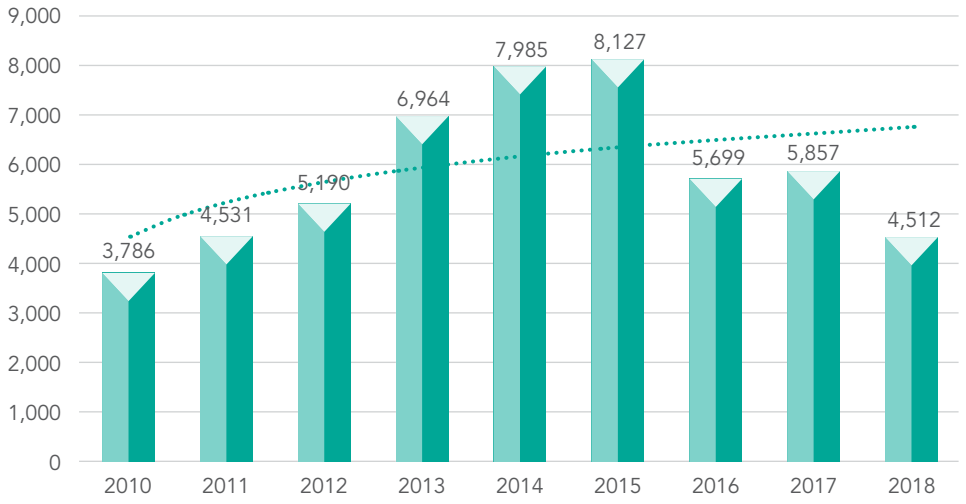
3.7.1 Agrotourism Potential in Penang

In Penang, possible attractions include open farms, homestays, freshwater fish breeding and sampling local delicacies such as seafood. In fact, homestay programmes are already experiencing some growth. As illustrated in Figure 28 and Figure 29, the total number of homestay guests and income increased by 19.2% and 10.7% respectively from 2010 to 2018.

So many aspects of the agriculture industry can be repackaged for tourists. Farms, plantations, husbandries, herbs and spices, paddy fields, and aquaculture can become attractions. For visitors, it can be fascinating to watch farmers husk paddy or watch fishermen tending to their ponds. Naturally, new infrastructure and an influx of visitors will follow, creating opportunities for local communities.

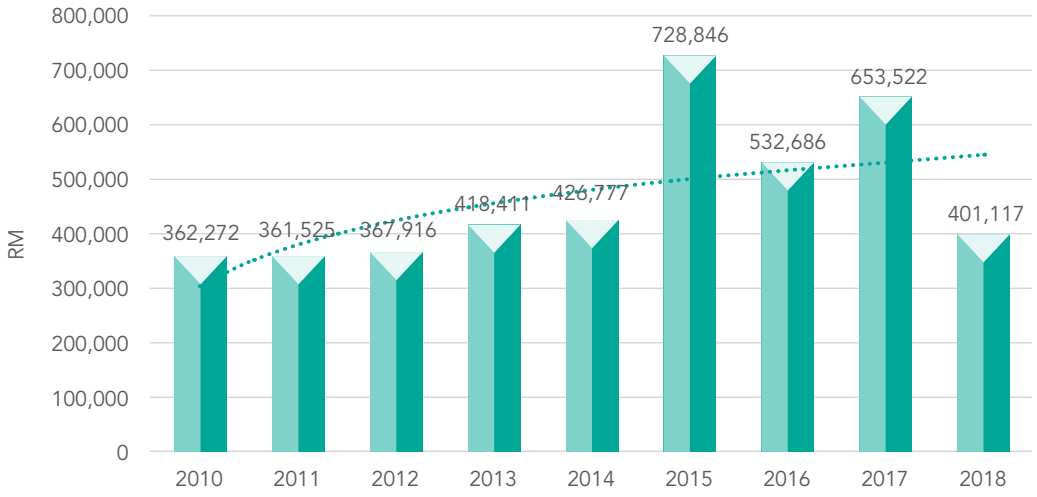
One such transformation may occur at Tasek Gelugor, in Seberang Perai Utara, which the state is turning into an agrotourism development area. It will be a hub for river tourism and a source of freshwater fish and prawns for visitors (PERDA , 2019). Alternatively, the success of Desa Cattle Farm in Sabah (Lo, 2016) can be recreated in Penang's cattle industry. There, tourists can feed milk to calves and grass to goats, while learning about milk processing at the same time. It is not hard to imagine something similar happening on Penang's cattle farms.

Figure 28: Homestay Tourists in Penang, 2010-2018



Source: Ministry of Tourism, Arts and Culture Malaysia.

Figure 29: Total Homestay Income in Penang, 2010-2018



Source: Ministry of Tourism, Arts and Culture Malaysia.

Meanwhile, aquaculture centres can attract students and foreign tourists, who can experience the process of breeding fishes in person. Given Penang's successful aquaculture industry, it is a prime spot for the transformation of these sites into tourist hotspots in addition to agricultural sites.

3.7.2 Agrotourism Categories

The Ministry of Agriculture has suggested a few initiatives in order to cater to a spectrum of tourists. Malaysian agrotourism initiatives are classified into several categories:

i. **Products based on Open Farms and Orchards:** Tourists can visit fruit and vegetable farms, floriculture farms, aquaculture farms, and bird nest centres. They can even perform hands-on work, such as plucking fruits and planting paddy.
ii. **Agricultural Education:** Tourists can be given a step-by-step dissection of the various aspects of the agricultural process. For example, they can learn about the fish and cattle breeding process or about food processing, thus gaining a deeper understanding of the daily lives of farmers and the work that has to be carried out.
iii. **Conservation and Tradition:** Given the rapidly changing world and the speed at which landscapes are transformed and traditions forgotten, tourists will receive an in-depth look at the importance of conserving not just the land and its resources, but also existing ways of life.
iv. **Homestays:** Tourists can live in a family's home, and thus experience the lifestyle of farmers and their daily lives.
v. **Local Delicacies:** Food is a huge part of the Malaysian experience, and adventurous tourists can have interesting hands-on experiences. For example, they can catch their own fish and have it prepared into local dishes.

3.7.3 Issues and Challenges

Despite its fame as an ecotourism destination, agrotourism in Penang is still developing. Tourists prefer places like beaches (e.g. Batu Ferringhi) and urban areas (e.g. George Town), while agrotourism is much more established in states such as Pahang and Kelantan. Therefore, an effective marketing strategy is required to publicise the efforts of local entrepreneurs, while upgrading existing infrastructures such as jetties and public transportation.

With that being said, agrotourism jobs are low paying and seasonal. It is hence reliant on the tourism industry to attract seasonal and off-seasonal tourists. Therefore, it can only be a supplementary source of income. Environmental degradation is another concern—in the rush to capitalise on a new venture, problems such as agricultural runoff, soil erosion and pollution caused by development of rural areas for agrotourism purposes pose a threat to the existing community. Regardless of the opportunities, the environmental quality of the area must be maintained.

Most worryingly, agricultural production may be disrupted. Since a site will be heavily regulated during its transition into an agrotourism spot, output and production will decrease while the cost of upgrading the site rises. Stakeholders must also carefully consider how the public reacts to the way the animals or workers are treated. A single misstep may lead to public backlash. Therefore, the agrotourism sub-sector is very much linked to a whole new set of concerns that stakeholders never had to consider in the past.

3.8 Agribusiness

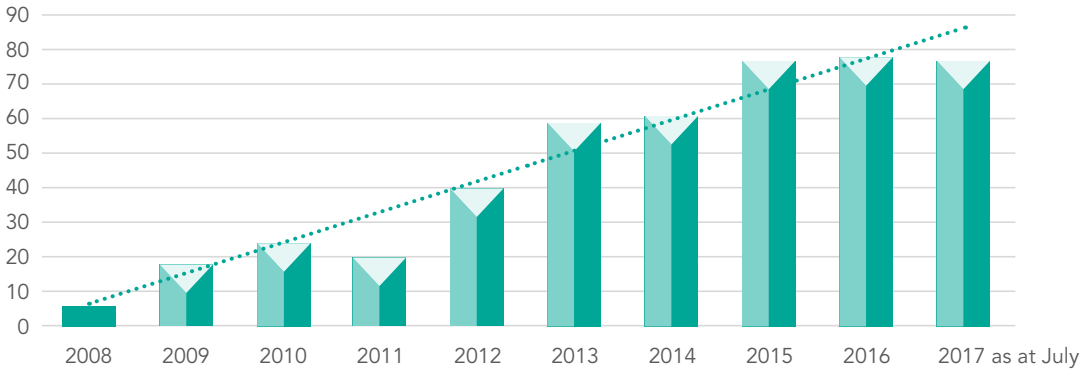
Quite simply, agribusiness is concerned with the commercial aspects of the agricultural industry. Specifically, it looks at agriculture from a business perspective instead of being simply a source of income and sustainability. It refers to businesses that are involved in the marketing of farm products such as warehouses, wholesalers, processors, retailers, etc. It is indeed an important component of the country's economy. Even though the agricultural sector's share of the national GDP has dropped from 29.9% to 7.8% in between 1970 and 2018, the sector still has a great potential in stimulating the economic development of the country. In 2018, the sector contributed about 2.2% to the state's GDP. Regardless, it still employed 1.2% of the local workforce.

Fortunately, an increase in global population and expenditure on food suggests that agribusiness has a bright future. However, market forces[8] have an important impact on the agribusiness sector. In fact, changes in consumer taste can alter what products are grown and raised. In his paper for the FAO, Mohamed (2014) predicts that the aquaculture, seaweed farming, bird's nest and herb sub-sectors have high growth potential, meaning that Malaysian and Penang-based producers can tap into a steadily expanding global market. The state can promote growth in agribusiness sub-sectors such as modern farming, supply chain management and halal hub, taking advantage of its established manufacturing and service sectors. The number of halal-certified food companies in Penang increased from a total of six in 2008 to 77 in 2017 (Figure 30). The export value of halal products increased from RM332 million in 2010 to RM18,566 in 2016 (Figure 31). China, Singapore and the United States are Penang's three major export destinations for halal food. The state's proximity to the Indian Ocean and its well-developed port and airport cargo transport facilities makes Penang a strategic export hub—especially since it is already within easy reach of large markets in Indonesia and Thailand.

Most products of Penang's agro-based industries are of high quality, which means that they can potentially be exported worldwide. The state is considering creating an internationally recognised brand to boost the competitiveness of local products. However, this effort must take logistical difficulties, buyer expectations and international standards into consideration. Private investment must be encouraged while ensuring that farmers, producers and local communities benefit.

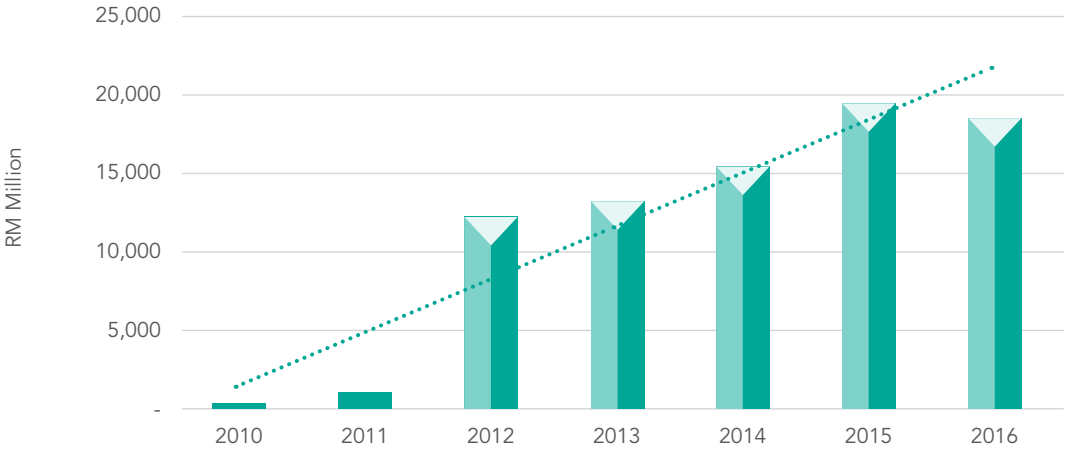
[8] Market forces refer to the collective effect of all the decisions made by individual participants in the economy - such as consumers and businesses - according to their free will.

Figure 30: Halal-Certified Food Companies in Penang, 2008-2017



Source: Halal Management Division, Penang

Figure 31: Export Value of Penang's Halal-Certified Products, 2010-2016



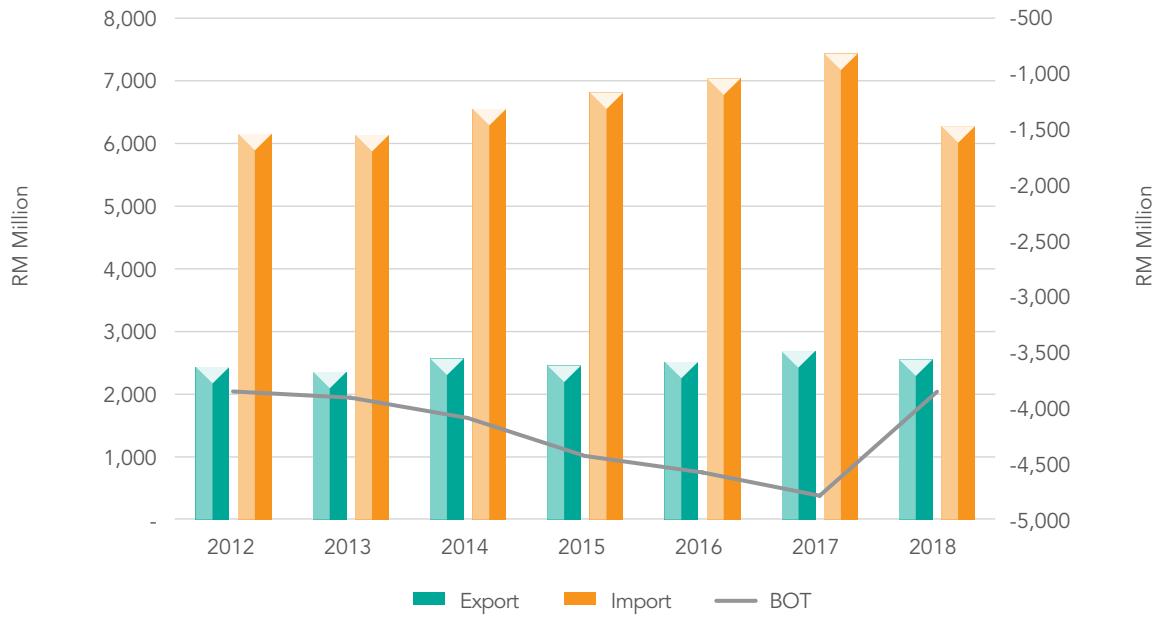
Source: Halal Management Division, Penang.

To this end, the state government is trying to reduce the dependence on middlemen in the marketing and distribution process, thus ensuring that farmers receive a commensurate return. Furthermore, approximately 66% of the people in the agricultural sector are over 50 years old, demonstrating a worrying lack of youth involvement (Jala, 2013). By making agriculture more profitable, the labour pool can be increased, particularly among youths. An influx of talent may create more entrepreneurs, who can transform the agricultural sector into a high-value industry.

3.8.1 Issues and Challenges

Food security is a national concern since Malaysia is still relying on imports for its staple food requirements such as rice. In 2018, the national food import bill was RM50.2 billion. RM31.6 billion worth of food was exported, leaving a deficit of RM18.6 billion. Penang's deficit was disproportionately large—it imported RM6.3 billion worth of food, while its exports were valued at only RM2.6 billion (Figure 32).

Figure 32: Food Exports, Imports and Balance of Trade (BOT) in Penang, 2012-2018



Source: Department of Statistics, Malaysia.

The agriculture sector should intensify its production to boost agribusiness efforts. Since land is limited, applying mechanization and advanced technologies would be the best way to intensify the agricultural production. Techniques such as more viable and high-quality seeds/breeds will also enhance both productivity and production output.

Agribusiness success depends on understanding market and target consumer needs and requirements. The main stumbling block to these efforts are middlemen, who exploit the farmers' lack of knowledge of market rates and the lack of channels to communicate with external buyers. This information asymmetry is particularly crippling for smallholders, who lack the data to boost productivity. In this case, information communication technologies (ICT) can play an important role. By improving access to information, farmers can be directly linked to input and output markets. The cost of agricultural exchange can be minimised, thus enhancing the welfare of the farming community.

Producers and their products should meet dynamic consumer preferences. For instance, the growing European Union market for tropical fruits can be exploited by producing fruit with a longer shelf life, farmed in an environmentally sustainable manner. Farmers must cater to the demands of domestic and international markets. Globalisation has improved information transfer, which makes consumers more aware and discerning about goods purchased. The demand for low-fat and sustainable organic foods, as well as fair trade certifications, are experiencing a steady rise. Convenience is also a major factor—if a middleman can deliver quality agricultural products directly to consumers for an additional charge, consumers would likely choose that option at the expense of farmers.

Sadly, farmers face huge challenges, and should therefore build on their existing skill sets. By venturing into marketing and food processing, they can remain competitive. Current state and federal government initiatives exist, but they are yet to create a significant change. Worryingly, the agriculture industry remains relatively unattractive to the younger generation, which views it as an unprofitable, outdated and labour-intensive occupation.

3.8.2 Initiatives

The 21st century villages (21 CV) programme was implemented by the federal government with three initiatives, including establishing state-driven integrated farms, private sector-driven fruit and vegetable farms, and improving village co-operatives (Bello, 2019). By transforming rural areas into the focal points for agricultural activities, a self-sustaining rural economy can be created. These villages will be equipped with broadband internet access to facilitate communication and modernise the sector. The current target is to create 132 new 21 CVs by 2020, funds permitting. The programme encompasses the development of large-scale modern agricultural farms, upgrading eco and agrotourism villages, promoting homestays, improving the production of palm oil, rubber and sago plantations, and strengthening cottage industries. Meanwhile, the Malaysian AgriFood Corporation's Agropreneur Programme is designed to produce "Master Growers", who will catalyse the transformation of traditional agricultural practices into agribusiness.

Efforts have been made to combat the problems caused by middlemen, such as FAMA's Agrobazaar initiative (FAMA, n.d.). Farmers and small and medium enterprises (SMEs) can sell their own produce to consumers directly through a physical bazaar or an online shop. However, a lack of promotion and marketing means that many consumers are currently still unaware of Agrobazaar's existence, although this situation is expected to change in the long run. Once proper supply chains are established, online sales and direct delivery to consumers will be more reliable, thus providing a strong challenge to middlemen (Safari and Masdek, 2015).

Modernising and diversifying sustainable agriculture are the main objectives of agro-food development in Penang, in line with Penang2030 strategic initiatives. Over the past few years, most of the state government's efforts focused on introducing new technology, such as biochemistry and biotechnology techniques. The state has also initiated several funding and incentive schemes to assist farmers develop technology, maintain infrastructure and obtain agricultural inputs. In 2017, the state government allocated about RM3.29 million for development programmes and RM300,000 to create human capital through various development services. In order to maintain sustainable growth, a number of agricultural programmes have been launched, including TKPM and Aquaculture Industrial Zones (AIZ). All the AIZs and TKPMs in the state are located in strategic, high-yielding locations to increase food security.

Ultimately, the agriculture sector really needs the energy and skills of youths to add value to the sector and turn it into a successful commercial enterprise. Hence, the government has started to provide a supportive environment for business opportunities. Besides the 21 CV and Agropreneur programmes, the Young Agro Entrepreneurs Fund or Tabung Usahawan Tani (TUT) was established. This microcredit scheme is an attractive option for rural youths. It provides interest-free loans of RM 5,000 to young entrepreneurs (below 40), who are involved in agriculture, livestock and fisheries activities, thus encouraging them to venture into potentially lucrative agro-based industries.

As for the aquaculture industry, the Performance Management and Delivery Unit (PEMANDU , 2011) has implemented integrated cage farming systems and increased R&D for major exports such as grouper, sea bass and tilapia. It is expected to create nearly 10,100 jobs nationwide.

Cities are also part of this agricultural transformation—urban communities have also been involved in "community farming" projects—crops are planted in urban areas to repurpose empty lands for urban farming efforts. Although these are primarily grassroots efforts, the impact on the health, food security, environment, social and economy of the state and its urban citizens is tremendous.

4. Policy Recommendations

With regard to the agricultural sector, the government prioritises food safety and security, sustainable development and the creation of a competitive industry. According to Kharas et al. (2010), agriculture is approximately four times more effective at increasing income among the poor compared to other sectors. Agriculture should therefore be transformed into a productive, high value, high-tech and market-oriented sector, working in tandem with other sectors. The current agricultural policy plan focuses on two main themes; 1) modernising agriculture and 2) the sustainable agriculture model.

4.1 Modernising Agriculture

The agriculture sector can be an economic powerhouse, but it is traditionally seen as an unprofitable venture. The government should make efforts to combat this perception to transform agriculture into a modern and sustainable sector. Since most Malaysian farms, especially smallholders, still use traditional farming practices and have limited access to the latest technology, knowledge and standards of sustainable practices, they are vulnerable to a wide range of uncertainties.

Farm output per hectare or productivity can be improved by: 1) the effective management of inputs (e.g. water, fertiliser and seed quality), and 2) minimising the risk of uncertainties (e.g. combatting pest, disease, climate change and market swings). To these ends, it is essential to adopt new technology such as improved crop varieties, modern machinery and ICT. These innovations will improve the production and wholesale value of agricultural products. Farmers can use natural resources more sustainably, while reducing food prices and becoming better connected to market opportunities. This translates to higher incomes, higher food consumption, greater nutrition and better allocation of household assets (Hazell and Haddad, 2001). In addition, the effective use of agricultural land and human capital, increasing the number of skilled workers capable of handling sophisticated technology, and intensifying R&D in priority areas would also help to increase the productivity and therefore farmers' income.

Knowledge transfer from research into farming practices is crucial. Continuous improvements in digital tools and data and collaborations among farmers and researchers across public and private sectors play an important role in modernising the agriculture industry.

4.1.1 Agriculture 4.0

Agriculture 4.0, or smart agriculture, refers to increased integration of IT and communications technology with agricultural production. Increasing demand for higher yields, product quality and higher environmental protection, compounded by climate change, has put pressure on the agricultural sector. Digital technologies can help farmers adapt by embracing automation, sustainability and cost-effective production. Farmers stay competitive and profitable, while simultaneously protecting local environment resources. This is not impossible—farms in Germany that adopted advanced digital technology have reported higher productivity while reducing excess reactive nitrogen compounds in soil, as well as decreasing herbicide and fuel use by 10% and 20% respectively (Adam , 2016).

Emerging innovations such as the Internet of Things (IoT) and big data should be incorporated into everyday operations. For example, IoT technology allows farmers to manage, monitor and control various operations remotely. Feedback from systems such as irrigation and farm input management can be automated and analysed through artificial intelligence. Even the levels of pests, soil moisture and livestock feed can be monitored through sensors. Therefore, routine operations can be streamlined, thus freeing up time and effort for other activities. Drones are an exciting innovation and are especially for suited for plantations—they can carry spray crops, conduct soil and field analysis and monitor the grounds. Countries such as Taiwan and China have already adopted drone technology, while Malaysia's agricultural sector lags behind. In the long run, these developments can save costs, decrease labour dependency, speed up productivity and enhance yields.

Agriculture is becoming increasingly knowledge-intensive. Farmers in Penang and Malaysia currently lack accurate, reliable and timely information. Agriculture 4.0 increases the ability of farming communities to connect with knowledge banks, networks and institutions through ICT. Collaboration and knowledge sharing can be promoted digitally through the e-agriculture community. On this site, models, methodologies, good practices and the adoption of open access and interoperability standards can be shared. The rapid growth of mobile phone ownership, computers and broadband infrastructure is an effective method for farmers to gather strategic and technical information (e.g. current market price, catchment areas and weather forecasts). Therefore, resource-poor farmers, particularly those in rural areas, will have an increasingly equitable access to agricultural knowledge.

These developments go beyond just production. Farmers can manage their business, keep tabs on market prices and make deals through their smartphones and other devices, thus competing directly with middlemen. FAMA's Agrobazaar initiative clearly has the potential for further growth.

However, important hurdles lie ahead—one of which is the aging workforce. Statistically, most farmers in Malaysia and Penang are relatively elderly, and may not be willing to adopt digital technology. Therefore, it will be important to target their children and younger farmers, who stand to benefit tremendously. Secondly, the process of implementing digital technology is expensive and best suited for large-scale producers—without subsidies or aid, smallholders are likely to get left further behind due to their lack of capital. Broadband infrastructure is a third issue—many rural areas receive limited mobile signal and landline internet connection, which are prerequisites for digitisation. Hence, telecommunication infrastructure must be upgraded in rural areas. Finally, a lack of information flow must be overcome. The DOA, DOF, DVS and other governmental agencies in the agriculture sector currently offer training and courses for farmers. However, not many farmers are aware of these programmes. For now at least, information dissemination through a combination of traditional (e.g. through banners and posters in urban and rural areas) and digital methods (e.g. online and via related department's website) would be more effective.

Taking these factors into consideration, Agriculture 4.0 can only be successfully implemented in Penang through the cooperation of the public sector, relevant private industries and the farming community. Digital industry players should create competitive and innovation-friendly landscape that allows equitable information flow and encourages fair competition, given existing systemic inequalities. Public institutions are welcome to help farmers navigate and invest in digital technologies. Farmers themselves must be prepared to change their habits and develop the required skills.

4.1.1.1 Encouraging New Technology

As mentioned earlier, many farmers, especially smallholders, simply cannot afford to invest in modern technology. One option for the government is to purchase the machinery and renting them to farmers for a short period (two or three years) so that farmers can decide on whether it is worth buying the machinery outright. Financial aid, such as instalment plans, allows farmers to complete their transition to a high-technology system with fewer financial constraints.

Unfortunately, most farmers are still sceptical about the outcome of new methods and technologies due to a lack of information. The government can raise awareness by providing incentives. For example, it can pay farmers who choose to adopt the technology, who can in turn spread information and teach other farmers how to use those new techniques. Since rural farmers are more likely to trust each other, this strategy is more effective than if it was imposed by outsiders.

4.1.1.2 The Farm Link Programme

Given that many farmers are aging and approaching retirement, it is urgent to transfer information between them and younger farmers. A proposed Farm Link Programme serves as an online resource and referral centre for farmers and landowners. New and established farmers seeking access to land and farming opportunities can connect to landowners who have farming and business opportunities available. This programme can also provide more information on getting started or developing farm succession plans.

This online linking service would be helpful especially for the following groups:

i. Young farmers looking for opportunities to gain experience;
ii. Young and new farmers looking for land, but face financial barriers in doing so;
iii. Established farmers looking for more land;
iv. Farm owners looking to lease, sell, or make land available for farming;
v. Retiring farmers who want to ensure that their land stays in agricultural production; and
vi. Farmers looking for farm managers, interns, or mentees.

A simple website needs to be created and designed and made available for free. Farmers, farm owners and service providers can create profiles and upload relevant information about the land and themselves. For example, someone looking to buy land will find useful information such as total acreage, region, type of opportunity, infrastructure, current production on farm and current farming practices—as well as the landowner's name and address. Meanwhile, the land owner can find a new farmer based on his/her experiences, skills and intended farming practices. Most importantly, the Farm Link Programme is a dynamic database containing a directory of new and experienced farmers who can support each other. A similar programme has been successfully applied in the United States, New Zealand and Australia.

4.1.2 Investment in Research and Development

Studies show that investing in R&D and adopting new technologies result in a higher productivity (OECD, 2015; Parham, 2007). Research is crucial for developing farm systems with improved production and increase profitability, while minimising their environmental impacts. Innovation, which includes creating and adopting new technologies, products and processes, would result in higher value-added agriculture activities.

Therefore, higher growth requires greater investment in agricultural R&D. The public sector in Malaysia is the primary source of agricultural R&D (primarily performed by government research institutes and public universities), while private investment in R&D is low and focused on export crops. Hence, increasing cooperation between research centres, the government, NGOs and private players in the agriculture sector enables better resource allocation and information dissemination while minimising duplication of research. For example, research institutes and universities can be linked to farms via collaborative R&D programmes and cluster initiatives. Attractive incentives need to be created to attract private sector investment in R&D. Research, policy development and the subsequent applications of knowledge can be centralised and focused. Coherent research priorities and monitoring/evaluation systems must be established.

The current public sector R&D system is a bottom-up system which relies on researchers to define project proposals. To improve the efficiency and responsiveness of the R&D sector, the government can highlight areas of interest while providing R&D project grants. The amount of funding will depend on the nature of the research. Current priorities include:

i. Research into demand-driven development which considers government, policy makers and farmers concerns;
ii. Research which considers developing cost-effective business models for sustainable agricultural development;
iii. Research that generates strong evidence for policy and programming; and
iv. Research which maximises contributions from the public and private sectors.

4.1.2.1 Improving Agricultural Statistics

High quality and reliable agricultural data is crucial. The outcome and performance of the agricultural sector should be monitored and assessed to obtain measurable data, which can be used to develop a better policy analysis and decision-making processes. Statistics are key for R&D activities and evaluating sustainability initiatives.

The main problem is overcoming the problem of inadequate or low-quality data gathering and production. This may be caused by a lack of sufficient technical tools, statistical methodology and survey frameworks. It is important to remember that a significant amount of data about agricultural production, especially crop production, comes from small-scale farmers who may not be able to measure, record or report data accurately. In order to improve data management, farm/farmer registration should be compulsory for every farmer, including small-scale farmers. By registering with relevant government departments, officials and researchers can monitor and evaluate their farm performance and output effectively. The data can be managed, monitored and verified through site visits systematically. Once a complete database is collected, data can be categorised and analysed in a way that makes sense. It is important to gather data that is not just related to production and values, but also on the socio-economics and the value of the sector to food security, nutrition and health for a thorough analysis.

Clearly, data collection as well as monitoring and evaluation efforts are time-consuming in terms of planning and execution. Fortunately, ICT tools allow researchers to gather data in a cheaper, faster and more accurate way. For instance, fishermen might use GPS navigation devices or fishfinders (or sounders) to locate schools of fish. These instruments can also be applied to collect and record bathymetric data (e.g. ocean/sea depth), vessel movements and fishing patterns. A systematic analysis allows fishing efforts to be more carefully planned and may even yield new fishing spots. Another potential area are digital data collection apps: they are an efficient, cost effective and smart way of collecting data which could bridge existing data gaps.

However, having the right technology alone does not guarantee that data will be interpreted correctly. Training is still essential. This problem can be resolved by training and engaging farmers, who are the true experts in their areas, in data collection. Given infrastructure hurdles such as the availability of the internet, a combination of traditional methods and apps might be best for the immediate future.

4.1.3 Talent Development in Agriculture

The agriculture sector needs to attract, develop and retain highly skilled and motivated people throughout the industry. In other words, attracting youths is a key concern. They need to know that it entails more than physical labour, that they do not necessarily need an agricultural background or qualifications to work in this sector, nor must they live in rural areas. Agriculture will soon become a high-value industry, and all sorts of young professionals, ranging from scientists to entrepreneurs, can find a niche.

This leads to a question of how to hire and retain skilled workers. For example, skilled scientists and engineers are needed to develop and modify technologies and techniques to boost yields. But how can they be enticed to work in agriculture? An improved workplace culture and career development opportunities needs to be established. Wages are another key area of focus—the manufacturing and services are much more lucrative and competitive.

The most effective solution is to encourage entrepreneurship in the form of agribusiness incentives. The government's current policy to provide financial assistance in the form of TUT loans, which has proven to be effective, should be continued.

4.1.3.1 Labour Dependency

Due to the current labour shortage, the sector is heavily dependent on foreign workers. The dependence of cheap, labour-intensive workers and adoption of low-skill based technologies hinder the development of more effective production methods as well as the shift to becoming a high value sector. Mechanisation will likely lead to decrease the demand for labour, thus potentially increasing revenue in the long run, while reducing labour input costs and related risks. Other solutions to overcome the current shortage problem are:

i. Increasing agriculture-related training and education;
ii. Increasing labour productivity;
iii. Improving living conditions in rural areas;
iv. Commercialising agriculture to attract the younger generations; and
v. Expanding agro-based industries in the rural areas.

Unfortunately, as stated previously, the wages offered are uncompetitive. Therefore, the wage gap between the agricultural sector and other economic sectors should be narrowed to mitigate this problem.

4.1.4 Investment in Agriculture

Ultimately, private investment in terms of physical, human and knowledge capital is needed. Government subsidies and aid can only go so far. There are high returns to investments in innovation, such as R&D, technology transfer, and farm extension and advisory. These investments will help contain upward pressure on food prices, especially given the scarcity of land and water resources, reduce the price volatility associated with tight market, increase overall food supply, and thus improving food security. Attracting private investment in agriculture requires a different set of policies. Highlighting profitable investment opportunities and providing incentives can be useful approaches.

One crucial approach is to present agriculture as a high-value sector. The development of rural infrastructure needed for irrigation, transportation and communication can effectively convince the private sector to invest.

Investor confidence can be increased by highlighting human capital and agricultural innovation systems. Government policies should support the development of high-quality education and advisory services to improve human capital. The government should also promote partnerships between local and international researchers to create effective innovation systems.

Since the agricultural sector faces notable weather, disease and price-related risks, effective risk management instruments are essential. Agricultural investors can be assured of a more stable income, thus cementing the agricultural sector as a stable area for growth. These considerations lead us to the following section.

4.1.4.1 Public-Private Partnership

A Public-Private Partnership (PPP) is a public sector procurement approach, whereby the government transfers a certain level of responsibilities to the private sector to provide public facilities or services (Ismail , 2013). It can be the source of innovative approaches since such partnerships can bring together business, government and civil society actors.

Through a PPP, the government can leverage public sector investment to boost private sector involvement in agriculture infrastructure, while filling in logistical and implementation gaps. In fact, the strengths of the public and private sectors complement each other by providing information and advisory services which address the needs of farmers and rural communities.

The government should therefore develop a PPP model for agriculture development in Penang. A successful PPP should clearly identify roles and responsibilities according to the unique skills and expertise that each partner can provide, with appropriate incentives designed to maximise their strengths. And it goes without saying that the government should mitigate some of the risks of doing business in the agriculture sector.

4.1.5 Enhancing Competitiveness

Competitiveness and profitability can be enhanced by increasing efficiency in the production, management and marketing of agricultural products. Given Penang's strategic location and established agricultural industry, it is important to develop a competitive market-oriented export culture to compete on an international level.

The competitiveness of the agricultural sector could be achieved in the following ways:

i. Developing and strengthening markets;
ii. Formulating and implementing high quality and safety standards;
iii. Selectively developing agricultural enterprises based on present and potential competitive strengths;
iv. Reducing dependency on labour;
v. Developing new and innovative products; and
vi. Capitalising on the product value chains, which generate sources of future growth and create new high-value industries.

However, the efficient supply of inputs such as fertilisers, pesticides, seeds, feeds as well as agricultural machinery and equipment is a constant problem. High input costs contribute to a higher cost of production, thus crippling the competitiveness of the industry. Therefore, efforts such as incentives should be implemented to make input industries more efficient and cost-effective.

Returning to the problem of imported feed, one potential solution is as follows: An integrated livestock and crop farm will help to reduce the input cost, since a farmer already grows the feed for the livestock and does not need to import it. In addition, the livestock manure can also be recycled to be used as a fertiliser for feed grain. The mixed sheep and crop system described in 3.6.2.2 may potentially prove a useful prototype, if implemented. Agricultural by-product and crop residues such as oil palm trunks, palm kernel cake, corn germ, and products resulting from peeling fruits and vegetables, can also be used as a livestock feed. Fully utilising agricultural wastes would therefore help to reduce dependency on imported feed as well as to improve the economic utilization of agricultural products.

4.2 Sustainable Agriculture Model

"Sustainability" is a vast term with various implications for the environment, natural resources, cultural traditions and the economy. For Penang's agricultural sector to be more sustainable, it should cover the three components of sustainable development: environmental, social and economic aspects.

Put simply, the state has a duty to manage natural resources (especially water and land) by balancing development with conservation, caring for communities involved, improving people's health through the production of nutritious food, all the while boosting the economy through rural employment opportunities. All this growth hinges on human capital—and as stressed earlier, youths play a huge role in implementing a sustainable agricultural model.

If this model is implemented properly, the state can enjoy an inclusive and sustainable agricultural growth by increasing food availability, generating income from production, creating employment and entrepreneurship opportunities along value chains and increasing rural development.

4.2.1 Improving Food Security and Nutrition

According to the World Food Summit (1996), "food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." From an economic point of view, a well-nourished population, particularly women and children, can result in better educational attainment, productivity and earning power. It is important to identify the meaning of food security and understand the conditions and the pathways required to achieve it.

Food security has three main dimensions, namely food availability, food accessibility and food utilisation. Food availability refers to a reliable supply and quantity of quality food. This depends on domestic production, imported food and food stocks. Food accessibility depends on individual/household income and their purchasing power, which must always take food prices, markets, equitable distribution and infrastructure into consideration. Food utilisation, meanwhile, is concerned with the proper use of food, as well as its quality, safety and nutritional knowledge of consumers. Maintenance of all these three dimensions over time would result in food stability.

Currently, food security strategies and policies are focused on food availability. However, having sufficient food at national/state level cannot guarantee that all the individuals and households have adequate food to eat. Socioeconomic and environmental factors such as low per capita income, income inequality, unemployment, access to market, climate change and political and economic factors must also be considered.

How food-secure is Penang? The availability, accessibility, and quality and safety issues need to be addressed. Understanding the state's exposure to specific risks and the resilience of its food system provide insights into its level of food security. Initiatives such as AIZ, TKPM and Agrobazaar are ultimately meant to increase food production and ensure food security. Furthermore, under Penang2030, the state government has introduced Feeding Penang Initiatives which would create more localized and urbanized farming to ensure food security. Although the production capacity of the state has increasing, some factors like climate change is adding a more unpredictable challenges for farmers which may contribute to financial and supply chain risks.

Therefore, some recommended policies are as follows:

i. Creating a state-level food security index: This index is needed to understand how food secure the state is. It addresses the issues of affordability, availability, and quality and safety of food in Penang. Hence, the state will have comprehensive information about local food security. The index can be used as a policy benchmark for the government to make strategic decisions.

ii. Employing a multi-stakeholder approach: A multidimensional issue needs multiple stakeholders to pool together their resources, knowledge and expertise. These stakeholders may include the state and federal government, the Ministry of Agriculture, the Ministry of Environment, the Ministry of Health, universities, research institutions, civil societies, farmers' organisations and private sector. Relevant institutions such as agriculture, trade, forestry, environment and health ministries and organisations should get involved to ensure that their policies consistently support food security goals. In addition, community involvement, especially from marginalised groups like women and smallholders, can give insights on the needs and views of the public.

iii. Providing nutrition education: Enhanced nutrition education and nutrition promotion of diverse, safe and nutrient-rich food is another important strategy to improve health through behavioural changes. Women should be the main targets, since they play key roles in their families' dietary diversity and health.

iv. Climate change adaptation: Climate change is worsening the food insecurity problem, and therefore addressing and adapting to climate and environmental changes (e.g. programmes for managing limited water supplies and promoting crops that thrive under new conditions) are essential.

v. Protecting land gazetted for paddy fields: Due to rapid urbanisation and population growth, areas designated for paddy plantation are shrinking and should be gazetted. Since paddy fields are "First Grade" land, where the land owner has rights to the use of the land, the land can be used for other purposes. The uncontrolled conversion of paddy fields is mostly driven by illegal and irresponsible developers. Local authorities or pihak berkuasa tempatan should be able to use local plans or rancangan tempatan as a reference. Special committees or task forces are required to monitor, coordinate and enforce laws. Law enforcement is crucial and acts must be passed to protect these First Grade lands. At the very least, the state should create an agricultural land policy. Meanwhile, existing, older acts should be reviewed and revised, such as the Waters Act 1920 (Act 418) and the Irrigation Areas Act 1953 (Act 386).

vi. Reducing food miles: Food miles measure the distance food travels from the farm to the consumer. The longer food travels the more the nutritional quality of the food diminishes, the less control there is on food safety and negative environmental effects are increased. Food miles can somehow be an indicator of agricultural sustainability. This is especially relevant in choosing local-grown products as much as possible over produce that has travelled many miles in refrigeration. Local food systems can therefore reduce food miles or the length of the supply chains as well as transportation costs, offering significant energy savings. It would also have significant impacts on greenhouse gas emissions and implications for climate change. Under Penang2030, the state aims to reduce the average food miles by about 20% by 2030. Hence, policies should focus on minimising imported foods and increasing local-grown food. Consumers would also benefit from fresher, better-tasting, and more nutritious food, while enhancing rural communities' and farmers' income. An effective strategy to reduce food miles and transport cost would be promoting urban farming which can significantly increase localised production. It would also increase food security and reduce carbon footprint.

vii. Developing the seed industry: Crop improvement and the delivery of high quality seeds and planting materials of selected varieties to farmers is needed to ensure improved production as well as meeting increasing environmental challenges. The availability of, and access to, quality seeds of a diverse range of adapted crop varieties is required to achieve food security. Hence, food security is dependent on the seed security of farming communities. In Malaysia and Penang, the seed industry needs to be further developed, as currently good quality seeds are mainly imported. In fact, expanding domestic food production and reducing the food import bill are in the national and state agenda. Positioning Penang as a green valley for seed hub is also one of the programmes proposed by Penang2030. Setting up a seed production hub can lead to focused efforts in sector development. It is important to include private sectors, as it can bring in the necessary expertise to the sector. Government incentives for investment in this hub can help attract private players.

4.2.2 Efficient Use of Available Land

Since Penang's agricultural land is limited, it is very important to fully utilise the available land resources. This project requires sufficient knowledge, skills and experience as a prerequisite for adopting new and modern technology, biotechnology and farming techniques. The agriculture sector should obtain as high yield per hectare as possible.

The Singaporean model can be adopted. Despite its lack of land and resources, the government has made efforts to boost agricultural productivity. Commercial indoor, rooftop vegetable farms and other urban and peri-urban farming have been implemented. Today, most farms in Singapore have adopted automation and other technological developments, and are located in agro-technology parks boasting modern infrastructure and facilities.

Vertical or indoor farming is a possible way to boost the efficient use of land and resources. For example, vegetables, especially leafy or quick-growing crops with high market values, can be grown in an indoor controlled environment under LED and fluorescent lighting[9]. This method is considered sustainable and will minimise stress on the environment. Through this farming method, farmers would be able to save water, reduce the risk of contamination and harvest produce faster. It yields more crops per square meter than traditional farming and greenhouses. This method may be attractive to newcomers, since it does not need to be carried out outdoors and can be done in urban areas. In fact, Malaysia's first aquaponic (mixed aquatic animal and plant cultivation) vertical urban /commercial farm was built in Penang. The proximity of such systems will make agriculture more visible to the general public.

Under Penang2030, the state aims to generate 100 new urban farming enterprises by 2030. To achieve this target a new model of agro-urban planning needs to be created. Agricultural parks should be seen as strategic projects of interaction between the demands of urban and of urban planning that enhance agricultural enterprises in urban and peri-urban areas. A multi-stakeholder policy development and action planning is needed. Because of its multidimensional nature, policy development and action planning should involve various sectors such as agriculture, fisheries, health, waste management, education, community development, etc. Training and technical assistance for community members to develop their own urban farming and food-related enterprises needs to be provided. Hence, it is recommended to establish a one-stop centre to assist entrepreneurs, in terms of sharing information, guidelines, providing equipment and training, and issuing licences and permits.

[9] The advances in LED technology have made it possible to create the perfect environment to grow vegetables/fruits at a large scale with shorter growing cycles and higher yields. This technology has made indoor farming very energy-efficient.

4.2.3 Sustainable Water Management

The rice sub-sector is one of the biggest water users in the agricultural sector. However, water scarcity is always a concern, given population growth and increasing demand from other sectors. This situation is compounded during the dry spells (which in turn is exacerbated by climate change), when the demand for irrigation water peaks. Hence, the state government should look for an alternative source of water for irrigation.

Paddy farmers should turn to new rice growing techniques to reduce water usage—which will also reduce energy expenditure and total production costs. Water-saving technologies, such as Alternate Wetting and Drying (AWD), can reduce water use in a rice field by about 25% (Joven , 2014). The AWD technique were successfully used in Thailand and Bangladesh. Basically, farmers can periodically drain their fields without any loss in yield. Furthermore, rice seedlings only need enough water to a depth of about 5-10 cm. In addition, the AWD method can reduce methane emissions in fields by about 75%.

MARDI has also conducted comprehensive studies on alternative cultivars and cultivation methods with high water use efficiency. For example, one study evaluated both lowland and "aerobic rice" varieties using different irrigation methods. Briefly, the cultivation of "aerobic rice" improved water productivity from 0.4 kg/m3 to 0.6 kg/m3 compared to irrigated wetland rice. The reduction in the water used was attributed to several factors:

i. reduced seepage and percolation losses;
ii. decreased losses through evaporation since there was no standing water; and
iii. water needed during pre-saturation period for land puddling was completely discarded.

Promising "aerobic rice" varieties with desirable traits (drought-tolerant with shorter maturation periods) demonstrated the best results. In fact, in areas where water is relatively limited, the best way to increase total rice production is by growing aerobic rice using the AWD technique.

However, determining the most suitable irrigation method mainly depends on field topography, water source, land use, pest and disease incidence and cultural practices. The AWD/"aerobic rice" combination is also labour and knowledge-intensive: it depends on good water and soil management, basic understanding of crop-water relationships and irrigation management (Chan et al., 2012).

4.2.4 Sustainable Development of the Fisheries Sub-Sector

Rapid development of fisheries sub-sector in Penang may raise sustainability management issues since it needs rapid and comprehensive management mechanisms. Fishing methods need to become more environmentally friendly to reduce the risk of overfishing. Educational programmes and public awareness should be promoted to develop responsible fishing practices. Local communities and stakeholders should be involved in the conservation process at all levels to enforce responsible fishing. Illegal, unreported and unregulated fishing is another concern, but unfortunately no data on the number of unlicensed fishermen is available.

Technical innovations, improved design and construction of commercial fish bases, further aquaculture R&D and government support will lead to a rapid increase in production and income in this sub-sector. Genetic research, which played a major role in the crop and livestock industry, can be implemented to increase production from aquaculture.

4.2.4.1 Sustainable Small-Scale Fisheries

Small-scale fisheries (SSF) encompass all activities along the value chain (both pre- and post-harvest; whether in an aquatic environment or on land) undertaken by men and women (FAO, 2015). SSFs contribute significantly to local food security, wholesome nutrition, local employment, poverty eradication, eco-tourism, and therefore to state and national economies. Oddly, their economic value has not been fully tapped yet, perhaps because not much data is available. Existing data is mainly centred on production and less focused on the socio-economic value. In fact, the number of people who depend on fisheries and aquaculture for their livelihoods is probably underestimated. Therefore, it is difficult for policy makers to make decisions. Unfortunately, SSFs in Penang and Malaysia are getting more marginalised as other industries expand along the coast (e.g. housing, tourism, aquaculture, etc.).

Below are some recommended policies to promote and enhance the contributions of SSFs:

i. Creating an appropriate management system: SSFs should apply fishing practices that minimise harm to aquatic resources and environment. The state should ensure effective monitoring and enforcement mechanisms to combat illegal and destructive fishing activities.

ii. Providing training: The state should facilitate and train SSF communities to participate in managing the resources that they strongly depend on.

iii. Involving the community: Both men and women should be involved in relevant decision-making and policy making processes, thus contributing their specific knowledge, perspectives and needs. The role of women in the industry is currently informal and not well understood beyond the fact that they are usually involved in the post-harvesting process. Amenities, services and policies to improve gender equality need to be implemented.

iv. Obtaining data from fishers: Involving fishers in data collection will help to generate good quality data. Fishers need to be trained on proper data reporting. Since they are currently encouraged to provide data on fish sales using fuel subsidies as an incentive, irresponsible fishers might intentionally misreport the sales accordingly. Data collected from fishers should be shared with the fishing community to strengthen the understanding of this sub-sector as well as their role.

v. Introducing new technologies and innovations: Applying new technologies and innovations will strengthen the long-term sustainability of SSFs. Technologies can be used to strengthen existing data collection systems, thus generating higher quality data.

vi. Investment in infrastructure: Appropriate investments, especially in post-harvest infrastructure, can help produce good quality and safe fishery products for both the domestic and export market.

4.2.4.2 Sustainable Aquaculture Development

In the face of declining capture fisheries' production, sustainable aquaculture development will become increasingly important as a way to supply sufficient food at affordable prices, and as an important income generator for the rural poor. Its output must increase at a higher rate than that of population growth, while remaining socially, economically and environmentally sustainable over the long run. The following policy measures are suggested:

i. Investment in aquaculture: Locals and foreigners should be encouraged to invest in a wide range of aquaculture activities to sustain and expand the sub-sector's contribution to the economy. Such activities can include programmes, incentives and projects. The government should incentivise preferred areas accordingly. For instance, the lucrative shrimp industry is a key area, with opportunities in sustainable techniques and practices, as well as modernizing existing technologies and machinery for product diversification, packaging and marketing. In addition, investment in R&D is another important factor to improve productivity, sustainability and management practices of the sector. It is important to bear in mind that aquaculture research is a long-term undertaking, and therefore the level of investment should be adequate and sustained in long-time.

ii. Conducting scientific research: Ongoing applied scientific research can develop practical solutions to both environmental and production problems. Since research should be demand-driven or determined by industry needs, it is best to encourage private-public research partnerships. This approach has been successfully carried out in the Philippines and Canada, with the results made widely available to culturists.

iii. Efficient use and management of natural resources: Intensive aquaculture is known to pose threats to the environment, as seen in our discussion of the fisheries industry in 3.5.3. Therefore, advanced technologies, organic aquaculture practices and effective management practices should be employed to keep aquaculture sustainable. Innovations such as raising species with short production cycles under semi-intensive system or integrated aquaculture-agriculture systems should be encouraged.

iv. Examining long-term demand and supply patterns: The state needs to explore demand from both domestic and world markets and regulate the supply of aquaculture products accordingly. It is particularly important to pay attention to long-term trends.

5. References

Adam, Ulrich. "'Farming 4.0' at the farm gates." 23 May, 2016. *Euractiv.* https://www.euractiv.com/section/agriculture-food/opinion/farming-4-0-digital-technology-at-the-farm-gates/. Accessed 23 October, 2019.

Annual Fisheries Statistics. Putrajaya: Department of Fisheries, 2015. www.dof.gov.my.

Ariff, O.M., Sharifah, N.Y. and Hafidz, A.W. "Status of Beef Industry of Malaysia." *Malaysian Journal of Animal Science* (vol. 18, no. 2, 2015, pp. 1-21).

Arshad, Mohd Fatimah, Raja Abdullah, Nik Mustapha, Kaur, Bisant, and Abdullah, Amin Mahir. *50 Years of Malaysian Agriculture: Transformational Issues Challenges & Direction.* Serdang: Universiti Putra Malaysia Press, 2007.

Ashton, Elizabeth. "The Impact of Shrimp Farming on Mangrove Ecosystems." *CAB Reviews: Perspectives in Agriculture Veterinary Science Nutrition and Natural Resources* (vol. 3, 2008). DOI: 10.1079/PAVSNNR20083003.

Bello, Hafis. "Sustainable Rural Development Initiatives in Malaysia: Case Study of the 21st Century Village Project ." 2019. *Conference Paper.* https://www.researchgate.net/publication/332143967_Sustainable_Rural_Development_Initiatives_in_Malaysia_Case_Study_of_the_21st_Century_Village_Project.

Chan, Chee Sheng, Zainuddin, Husain, Saad, Abdullah, and Azmi, Man. "Productive Water Use in Aerobic Rice Cultivation." *Journal of Tropical Agriculture and Food Science* (vol. 49 no. 1, 2012): pp. 117-126.

Chan, H.C., Poh, H.H., and Tan, Y.H. "The Economic Potential of the Penang Fisheries Sector." *Economic Briefing to the Penang State Government.* 6(8), 2004. pp. 5-11.

Dardak, Rozhan Abu. *Transformation of Agricultural Sector in Malaysia through Agricultural Policy.* Serdang: Malaysian Agricultural Research and Development Institute, 2015.

DOSM. *Economic Census. Department of Statistics, Malaysia.* 2016. https://www.dosm.gov.my.
—. *Household Expenditure Survey.* Putrajaya: Department of Statistics, 2014. www.dosm.gov.my.
—. "Selected Agricutural Indicators." 2018. www.dosm.gov.my.
—. *The National Economic Census. Department of Statistics Malaysia.* 2015. https://www.dosm.gov.my/v1/.

DVS. Malaysian Livestock Breeding Policy. Putrajaya: Department of Veterinary Services, 2013. http://www.dvs.gov.my/dvs/resources/user_1/DVS%20pdf/Livestock_Breeding_Policy.pdf.

El Hadary, Yasin Abdalla Eltayeb, Samat, Narimah, and Hasni, Rosmiyati. "Land Use Changes and its Impact on Local Communities at Seberang Perai Tengah of Penang, Malaysia." *Workshop on Issues in Peri-Urban Regions and Ways towards Sustainable Peri-Urban Features.* vol. 9, 2011.

FAMA. "Agrobazaar (Outlet Runcit FAMA)." n.d. *Federal Agricultural Marketing Authority.* http://www.fama.gov.my/en/agrobazaar-outlet-runcit-fama-#.WX71gvmGPIU. Accessed 31 July, 2017.

FAO. *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication.* Rome: Food and Agriculture Organization, 2015. http://www.fao.org/3/a-i4356en.pdf.

Gallet, Chris A. "The Income Elasticity of Meat: A Meta-Analysis." *Australian Journal of Agricultural and Resource Economics* (vol. 54, no. 4, 2010): 477-590.

Handisyde, Neil, Rossm Lindsay Glenn, Badjeck, M-C, and Allison, Edward H. *The Effects of Climate Change on World Aquaculture: A Global Perspective.* Stirling: Department for International Development, 2014.

Hazell, Peter, and Haddad, Lawrence James. *Agricultural Research and Poverty Reduction.* Washington, D.C.: International Food Policy Research Institute, 2001.

Ismail, Suhaiza. "Factors Attracting the Use of Public Private Partnership in Malaysia." *Journal of Construction in Developing Countries* (vol. 18 no. 1, 2013): pp. 95-108.

Jala, Idris. "Agriculture is a Sector that is still Important to Malaysia's Economy." 30 September, 2013. *The Star.* Accessed 23 October, 2019.

Joven, Bernadette. "New irrigation technique can ease drought effects for rice farmers." 24 June, 2014. CGIAR. https://ccafs.cgiar.org/fr/blog/new-irrigation-technique-can-ease-drought-effects-rice-farmers#.XbsP8ZozbIV. Accessed 31 October, 2019. <https://www.bangkokpost.com/learning/learning-news/290269/growing-rice-with-little-water>.

Kee, Stephanie. "A Rice Bowl Under Threat?" January, 2018. *Penang Monthly*. https://penangmonthly.com/article.aspx?pageid=9947&name=penang_a_rice_bowl_state_under_threat. Accessed 23 October, 2019.

Kharas, Homi, Zeufack, Albert, and Majeed, Hamdan. *Cities, People, and the Economy : A Study on Positioning Penang.* Washington, D.C.: World Bank, 2010. http://documents.worldbank.org/curated/en/802841468331912672/Cities-people-and-the-economy-a-study-on-positioning-Penang.

LKIM. *Fishermen socio-economic and household data 2007/2008.* n.d. http://www.moa.gov.my/.

Lo, John. *Desa Cattle is now the pride of Sabah*. 19 November, 2016. http://www.dailyexpress.com.my/read/2309/desa-cattle-is-now-the-pride-of-sabah/. 30 October, 2019.

Mansor, Norudin, Rashid, Kartini Mat, Mohamad, Zuraida, and Abdullah, Zalinawati. "Agro Tourism Potential in Malaysia." *International Academic Research Journal of Business and Technology* (vol. 1, no. 2, 2 015): pp. 37-44.

Menon, Jayant. *Government-Linked Companies: Impacts on the Malaysian Economy.* Kuala Lumpur: Institute for Democracy and Economic Affairs, 2017. http://www.ideas.org.my/wp-content/uploads/2017/12/PI45-Government-Linked-comapnies-and-its-Impacts-on-the-Malaysian-Economy-V4.pdf.

MOA. *Statistics.* 2015. http://www.moa.gov.my/statistik.

Mohamed, Zainal Abidin. *Public Sector Support for Inclusive Agribusiness Development: An Appraisal of Institutional Models in Malaysia.* Rome: Food and Agriculture Organization of the United Nations, 2014. http://www.fao.org/3/a-i3965e.pdf.

Mok, Opalyn. "Without Rain, Penang Paddy Farmers may lose RM37m Rice Bowl." 2 May, 2016. *Malay Mail.* https://www.malaymail.com/news/malaysia/2016/05/02/without-rain-penang-paddy-farmers-may-lose-rm37m-rice-bowl/1111223. Accessed 23 October, 2019.

OECD. *The Future of Productivity.* Paris: OECD, 2015. https://www.oecd.org/global-forum-productivity/library/The-future-of-productivity-policy-note-July-2015.pdf.

Omar, Sarena Che, Ashraf Shaharudin and Siti Aiysyah Tumin. "The Status of the Paddy and Rice Industry in Malaysia." 2019. http://www.krinstitute.org/assets/contentMS/img/template/editor/20190409_RiceReport_Full%20Report_Final.pdf.

Parham, Dean. "Empirical Analysis of the Effects of R&D on Productivity: Implications for Productivity Measurement? ." *OECD Workshop on Productivity Measurement and Analysis* . Paris: OECD, 2007.

PEMANDU. "Chapter 15: Transitioning from Agriculture to Agribusiness." *Malaysia: Economic Transformation Programme (ETP) - A Roadmap for Malaysia.* 2011: pp. 513-550.

PERDA. "Pembangunan Agrotourism Tasek Gelugor." 4 October, 2019. http://www.perda.gov.my/index.php/ms/pembangunan-agrotourism-tasek-gelugor. Accessed 30 October, 2019.

Safari, Suhana, and Masdek, Nik Rozana Nik Mohd. "Consumers' Perception and Acceptance of Fresh Agriculture Product Purchased through e-Business." *Journal of Agribusiness Marketing (Malaysia)* (vol. 7, 2015): pp. 49-59.

Sim, Enzo. "Winning Allies to Secure Penang's Water Supply." July, 2019. *Free Malaysia Today.* https://penangmonthly.com/article.aspx?pageid=15678&name=winning_allies_to_secure_penangs_water_supply. Accessed 23 October, 2019.

Supply and Utilization Accounts Selected Agricultural Commodities. Putrajaya: Department of Statistics, 2018. www.dosm.gov.my.

World Food, Summit. "Rome Declaration on World Food Security." 1996. http://www.fao.org/3/w3613e/w3613e00.htm.

Zakaria, Azlina and Abdul Rahim, Abdul Rahman. "An Overview of Fruit Supply Chain in Malaysia." *Jurnal Mekanika* (vol. 37, 2014): pp. 36-46.