

Chapter 10

Impacts of Climate Change on Agriculture in Malaysia



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Abstract Climatic change is a reality that faced by the world that seems to be failed understanding of the phenomena. Human being can reduce the impacts of climatic change. They can do so if they realize the need to work together. The authors of this chapter attempt to show how human activities can increase the negative impacts of climatic change by way of lifestyle. For example, human beings contribute to surface water runoff and flooding. Human beings can also increase the carbon dioxide content of the air from fuel burning. The options would be alternatives or greener fuel and reducing the number of cars on the road. In terms of the alternatives, we must increase the solar research and applications and manage the nitrogen and carbon cycle through understanding of the environment and the ecosystem. The alternatives and options are exposed in the book chapter. Moreover, this chapter also tries to reduce the unnecessary fear of the climatic impacts on human beings by suggesting steps and alternatives and possible international cooperative efforts.

Keywords Climate change · Lifestyle · Agriculture · Malaysia

10.1 Introduction

Malaysia is a tropical country that is located in Asia with potentials for crop production. Malaysia is the second largest exporter of oil palm in the world and third largest rubber producer in the world (United States Department of Agriculture 2017). Fruit trees such as jackfruit, cempedak, breadfruit, bananas, durians, and coconuts are planted extensively in Malaysia. According to the World Bank, 24% of the total land in Malaysia is agriculture in year 2014. Malaysia has an area of 78,390 square km in year 2014, with 7.6 million hectares of arable land suitable for crops.

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Agriculture is very important to Malaysia because agriculture provides major food for Malaysians. However, Malaysia had not focused much on agricultural development since the implementation of the eighth Malaysian Plan in year 2001. Malaysia had become too dependent on food import. In year 2015, Malaysia imported a total of RM45 billions of food, which represents around 20% of the total budget of a country in that year (Carvalho et al. 2016). This means that Malaysia is not self-sufficient in food. Malaysia is turning their agricultural land into housing and buildings. Malaysia is fast urbanizing and declares 75% urban and 25% rural in 2016 (The World Bank 2016a). Fruit trees had been chopped off to make way for housing and urbanization in Malaysia. China had targeted 50% urbanization and 50% rural for the Chinese. China maintains their farmers at rural area, by giving lands to their farmers to plant crops to feed the urban people and for exports. China could not afford not to produce food and import food because the population in China is huge at 1.4 billion people. To make matter worse, Malaysia is more vulnerable to climate compared to China. Climate change can occur everywhere in the world. Climate change is a change in the typical or average weather of a region or city. This could be a change in a region's annual rainfall, a change in Earth's average temperature, or a change of typical precipitation pattern (NASA). Agriculture production sector is most directly impacted by climate change. Being a traditional agriculture country, Malaysian agriculture is thus vulnerable to the impact of climate change. Malaysia must assess the source of climate change and minimizing the impacts of climate change on agriculture to ensure sustainability of the agriculture.

10.2 Literature Review of Climate Change and Agriculture

This section reviews the relationship between climate change and agriculture. Climate change, agriculture production, and the contribution of the agriculture sector to the economy will be discussed. The success stories of agriculture in other countries such as Southeast Asia, Europe, and the United States are discussed as well to enrich the understanding of how these countries had prepared themselves for climate changes in the future with advances in technology, idea and adaptability of people, and crop and animal production.

10.2.1 Climate Change and Agriculture in Malaysia

Agriculture and climate are interdependent. Plants are the primary factories of agriculture. Plants take in carbon dioxide from the air through their leaves. They take in moisture and chemical substances from the soil through their roots. Out of these, plants make seeds, fruits, fibers, and oils that man can use by using the energy of the sunlight. Animals, on the other hand, depend on plants for their food; they can eat many parts of plants that man does not, such as stems and leaves of grasses. The

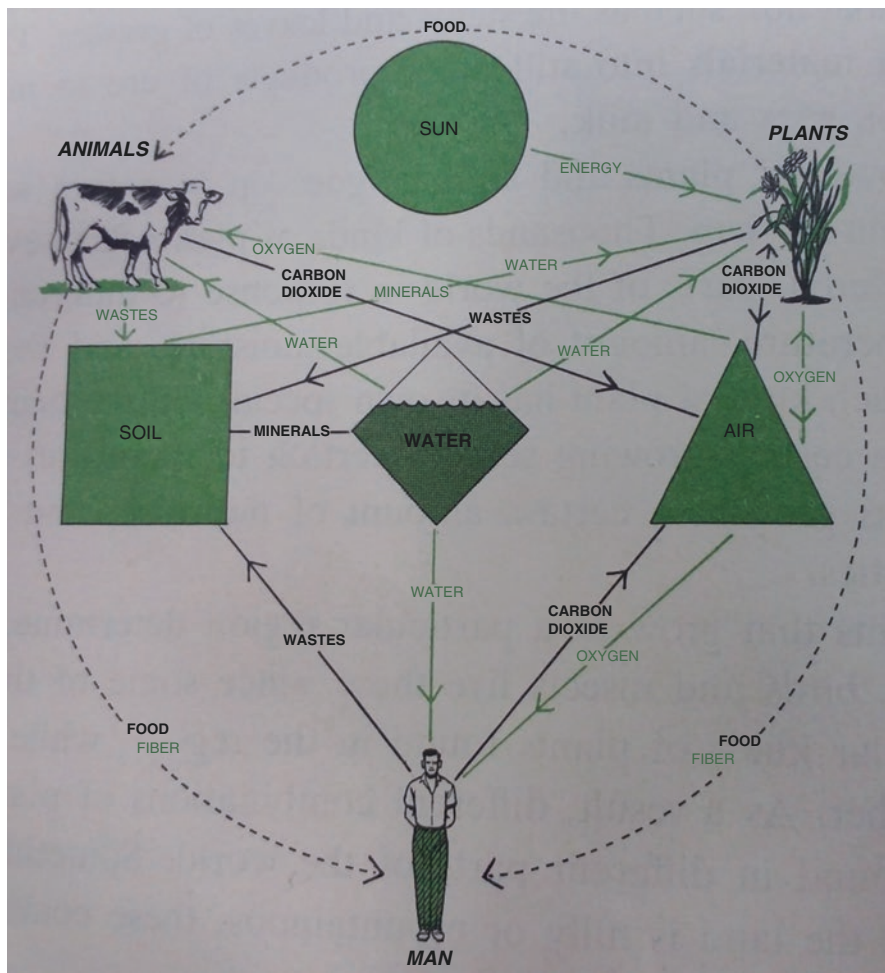


Fig. 10.1 Biological production process of agriculture (Source: Mosher 1966)

animals transform plant materials into other products of use to man: meat, hides, wool, eggs, and milk. The diagram of the nature of agriculture is shown in Fig. 10.1.

There are certain characteristics of the biological production process of agriculture that are beyond our control. Human beings do not create sun, water, air, and soil. The sun, water, soil, and air are the biological production factors that are needed by the plants and animals to grow. However, the growth of plants and animals is disrupted if human beings destroy the biological production factors such as the sun, water, air, and soil. Thus, human beings must understand the biological production process of agriculture and prevent from harming the biological factors through human activities such as rapid urbanization, accelerate house construction, chopping down trees, and flattening the mountains.

Climate changes can be nature-made and man-made. For nature-made climate change, Malaysia cannot do much about it and must be prepared to face the climate changes. For the man-made climate change, Malaysia can avoid it by changing production strategies and consumption styles. The man-made climate change is caused by urbanization, illegal loggings and development projects near the coastal areas and rivers, and careless exploitation of the resource and bad management practices especially land management.

Urbanization is the process by which towns and cities are formed. Increasing number of people begin living and working in the urban areas. When urbanization occurs, the cutting of forest trees and exploitation of land will accelerate. More buildings and houses are built to benefit mankind in the urban areas. Urbanization contributes to destruction of the forests and may contribute to man-made climate change. One of the significant examples in Malaysia is the conversion of paddy land to housing and urban centers and the destruction of major rivers.

In recent years, Malaysia has set its sight on the Vision 2020 Plan, which could propel the country to be a developed nation with high-income status at the gross national income of US\$15,000 per capita. Many buildings, houses, and factories are built in order to speed up the Malaysian Vision 2020, to become developed nation. Thus, activities that harm the environment such as tree cutting from areas that were formerly forests for tree crop production and urbanization contribute to environmental damage. Land reclamation in Penang was executed for urban development. This caused damage to the ecosystem and agriculture especially when permanent structure was erected physically. The human quest for modern development has altered the local weather and climates, releasing greenhouse gases to the air and coal burning which release more toxic to the air. Human activities bring harm to the in situ climate, soil, and water degradation through conversion of paddy fields to build houses for the people have caused the agriculture sector to deteriorate. Table 10.1 shows that the Malaysian policies have shifted from agriculture in rural area to services and manufacturing which is located in urban areas.

The national focus on the agriculture sector of Malaysia has dropped as shown in the contribution of sectors to Malaysian GDP in year 1965 and 2015. The percentage of contribution of agriculture has dropped from 31.5% in year 1965 to only 8.9% in year 2015. Although the percentage of agriculture to GDP is only 8.9%, Malaysia must not abandon agriculture because agriculture represents the source of food to the people of Malaysia. Moreover, the agriculture sector also employed

Table 10.1 Contribution of sectors to Malaysian GDP in year 1965 and year 2015

Sectors in Malaysia	% to GDP in year 1965	% to GDP in year 2015
1. Services	43.9	53.5
2. Manufacturing	10.4	23
3. Agriculture	31.5	8.9
4. Construction	4.1	4.4
5. Mining	9.0	9

Source: Department of Statistics Malaysia (2016)

Table 10.2 Shows the contribution of agriculture sectors in year 2015

Subsector of agriculture	% to agriculture sector in year 2015
Oil palm	46.9
Livestock	10.7
Fisheries	10.7
Rubber	7.2
Forestry and logging	6.9

Source: Department of Statistics Malaysia (2016)

1.1 million people. The country that abandons agriculture has to import foods. Malaysia has imported about RM45 billion worth of foods in year 2015 because of not growing them. Malaysia has stagnant agriculture sector and focuses on exporting crops to other nations. Table 10.2 reflects that Malaysia does not focus on food production.

As shown in Table 10.2, it can be observed that the oil palm and rubber contribute around 55% to the agriculture production in year 2015. Malaysia planted 5.6 million hectares of oil palm (Malaysian Palm Oil Board 2016) and 1.07 million hectares of rubber (Malaysian Rubber Board 2016). Malaysia has a total of 7.6 million hectares of arable agricultural land. Oil palm plantation and rubber plantation have taken up 87.76% of the total agriculture land (6.67 million out of 7.6 million hectares). This means that Malaysia is not having enough farmland for other essential food crops. We cannot eat food from oil palm and rubber. Malaysia hopes to use money obtained from export of oil palm and rubber to import foods. But that is not enough as food import bill is growing very high. In the year 2015, it was at RM45 billion or 17% of total national budget expenditure at RM260 billion a year. We can learn from success stories of agriculture in Southeast Asia (Thailand and the Philippines), Europe (the Netherlands and Switzerland), and the United States of America (USA) if we want to contribute to local food sufficiency and global food security in the face of climatic changes.

10.2.2 Preparedness of Thailand and Italy

Thailand has successful agriculture sectors. Their agriculture is highly competitive, diversified, and specialized. Rice is the top crop in Thailand. Sixty percent of the 13 million farmers grow the crops (SCB Economic Intelligence Centre 2017). Agriculture contributes about 10% of the Thailand GDP (The World Bank 2016b). Forty percent of the labor force work in the agriculture sector. Agriculture provides important jobs to the Thai people. Thailand grows a lot of food crops such as durian, bananas, rice, lychee, and many fruits for local consumption and export (mostly to Malaysia). Thailand had not abandoned agriculture and become self-reliant in foods.

Italy has good planning on agriculture. The northern part of Italy has a strong tradition in pig and cattle breeding, whereas the southern part of Italy is allocated for wheat, tobacco, olives, stone fruit, sugar beets, and tomato cultivation. This shows that Italy has a good planning in agriculture. Industrial and developed country like Italy had not abandoned agriculture, even though about 74% of the Italian GDP is generated from their service sector (The World Bank 2016c).

10.2.3 Successful Agricultural Stories in the Netherlands and Switzerland

The Netherlands is a small country and only 1/8 the size of Malaysia. The climate is cold and not very suitable for crop production. It is surrounded by sea with very limited land. However, the Netherlands never abandon agriculture. The Netherlands has 2.5 million of cattle to produce milk and Malaysia only has 30,000 cattles to produce milk. The self-sufficiency of milk in Malaysia is 5% of local demand. Ninety-five percent of milk in Malaysia is imported from Australia, the Netherlands, and New Zealand. The Netherlands produces Dutch Lady Milk, and it has good agricultural universities in the world such as Wageningen University, Utrecht University, University of Twente, and University of Amsterdam that do extensive research on agriculture. Another country that never abandon agriculture is Switzerland. Switzerland mountains have cold climate. Most of the countries may not be suitable for tropical fruits. The geographical area of Switzerland is surrounded with alps and limited land for agriculture. But this does not undermine the Swiss to develop its agriculture. The Swiss cultivates herbal and produces herbal candy, named Ricola since 1930. The Swiss now sells Ricola to every part of the world. We can observe the vision and the planning of the country on developing agriculture and make the country great. This country may not be affected by massive climatic changes.

10.2.4 Success of Agriculture in the United States of America

The United States of America (USA) often asks the developing countries to develop industries and urbanize the people to be developed nation. However, the United States had never abandoned their agriculture because agriculture represents their source of food. Farm output only represents about 1% to GDP and employs 1.4% of the total US employment (United States Department of Agriculture 2016). The United States never abandons the agriculture and invests heavily on agriculture especially in science and technology, research and development, product development, and farmers' productivity. The United States has agricultural experimental stations in most states funded by the government and has the cooperative extension

service to educate the farmers on crop plantation and changes of crop production and utilization strategies. The United States had always recognized the importance of technology to adapt to climatic changes.

10.3 Malaysian Development and Agriculture

In recent years, Malaysia had set her sight on Vision 2020 Plan, with the idea of propelling the country to be a developed and high-income nation with gross national income of US\$15,000 per capita. Many buildings, houses, and factories were built in order to speed up Malaysia to become developed nation. The activities associated with the massive infrastructures built could harm the environment. Cutting of trees for urbanization and indiscriminate land reclamation such as those in Penang could bring damage to the ecosystem of the sea and fishery. The human quest for modern urban living has altered the local weather and climates. The advent of cars and the increase of lorries and buses had resulted in release of greenhouses gases to the air, and the act of coal burning released more toxic materials to the air. Human activities could do permanent harm to the climate, soil degradation, and the destruction of water supply.

Malaysia declares itself as 75% urban and 25% rural area to achieve high urbanization, industrial, and developed state in year 2020. Malaysia has emphasized on heavy industry, knowledge economy, and information communication technology (ICT) and services and to abandon agriculture. Agriculture happens in the rural area. If the rural area experiences area shrinkage, it is hard to plant crops and foods. Malaysia has to rely on imported food. Not all wrong policies on agriculture fall on mismanagement and wrong planning; young generation also plays a role in attributing to wrong policies on agriculture. Young people do not like to be farmers. They conceived agriculture as dirty, poor, and difficult. Young generation or generation Y would like to work in urban area and does not like to work as farm producers in rural areas. That is the reason why Malaysia has 80% urban and 20% population. The young generation does not like to assume the farming role of their parents. The older generation may need to sell the land to housing developers. The housing developers convert the agricultural land to housing land and build houses. This action alters the environment of agriculture and contributes negatively to climate change in Malaysia with prolonged dry seasons, intensive rains, and massive flooding of the country. The urban areas faced flash floods.

The government of Malaysia also does not build adequate facilities and infrastructure in small rural towns to encourage farmers to stay in rural area to plant crops. Facilities and infrastructure access in small town, agricultural processing facilities such as small and medium enterprises, and agricultural marketing facilities such as organized fresh market and kiosks to sell farm products are not there in small towns. Government had not given incentive or attention to retain people in agriculture. New towns are developed and old towns near to rural area are left declining with limited assistance. All the developments of infrastructure are focused on big cities only such as Kuala Lumpur, Johor Bahru, and Penang. Malaysian small

rural towns do not have facilities like those found in agropolitan in Europe and America. In United Kingdom, the government gives incentives to the people to stay in rural area to produce food and prevent traffic and people congestions in urban area. The town planning is effective and the rural area is green. The climate change has little effects on the United Kingdom. The United Kingdom has large areas of green grass for the dairy cattle to consume and produce milk to feed the British. Their urbanization is focused and had not resulted in much man-made climatic change. Housing, urban infrastructure, and automobiles had not dramatically changed the living environments with ample food supply. They are prepared for climatic changes.

10.4 Impacts of Climate Change on Agriculture

United States Environmental Protection Agency (EPA) highlights that agriculture and fisheries depend very much on climate changes. Increases in temperature and carbon dioxide (CO₂) contents of the atmosphere can vary some crop yields in some places. Crop yields also depend on nutrient levels, soil moisture, and water availability. Droughts and floods can cause the crop yield to drop and food supply to shrink.

Climate change can cause the costs of production to increase because the land and labor productivity will be reduced. For example, the crops yield before climate change is 100 kg. When there is climate change such as the soil becomes acidic, the crop yield is reduced to 50 kg.

Impacts of climate change are:

1. Drop in productivity
2. Decrease in income and general welfare
3. Reduction in food security and increase food prices
4. Decrease in livelihood and welfare of farmers, followed by all citizens

10.4.1 *Effect of Climate Change: The Case of Thailand Agriculture*

The drought in year 2015–2016 contributes to the decline of rice production of 16% from 19.8 million tonnes to 16.5 million tonnes (Luedi 2016). However, the universities in Thailand help Thailand to develop drought-resistance seeds via genetic engineering and associated technologies. Government provides funding. However, 960,000 hectares of paddy remains unplanted due to shortage of water (Lee 2015). Thus, we can observe that the impacts of climate change are huge. We must understand it, reduce the man-made climatic changes, and adapt to nature-made climatic change.

10.5 The Causes of Climate Change in Malaysia

When there is man-made climatic change, the environment can change as well. Groundwater that becomes sour than before, soil that becomes more acidic, and increase in temperature are the examples of environmental change. This means that Malaysia is no longer planting in normal condition. Thus, Malaysia needs to make adjustments to the agriculture such as improving seeds, buying extra machines, and so forth. Malaysia is paying high costs because the indigenous technology was not developed. One major contribution to the climate change is cutting down forest to build more houses and roads. The question is why we need so many houses and roads in Malaysia. Malaysia is losing its green. If the country is losing its green, the entire ecology of agriculture may be permanently altered. During the 1950s and 1960s, the durian flowering in Malaysia is helped by the flying foxes. The flying foxes eat the nectar and pollinate the durian flower from Batu Caves to Sepang and all the villages in Malaysia. Durian trees were productively fruiting in Malaysia main durian areas. Now, in year 2017, with the cutting down of jungle and fruit trees to build houses and buildings, the flying foxes diminish and the productivity of durian decreases enormously. Without those flying foxes, the durian industry has limited production potential. The people in Malaysia have no more nice durian to eat. If the Malaysians want to eat durians, they need to import durians at high cost from Thailand. It is now difficult to grow durian in most parts of Peninsular Malaysia, with regularity of flowering season.

One can say we need to build more houses and roads when there is increase in population over time. However, that is not true. We can observe the examples of the United States, the United Kingdom, and Japan. In the United States, it is hardly any change in the road system or more roads though the population increased from 160 million people in the 1950s to 340 million in year 2017. The planning of the United States is incredibly good. The United States had been seriously noting the climatic change. Again, Malaysia should be prepared and plan for their development in the midst of the climatic changes. Malaysia must be mindful of man-made climatic changes and implement useful programs to save her food production capacity.

House construction done with unwise strategies or adverse plans may lead to flooding because the water from rain could not be absorbed into the soil once the land is cemented and the trees are gone. The retention of water may cause severe flash flooding in Malaysia. Malaysia has undergone tremendous development and urbanization. Seventy-five percent of the Malaysians live in urban (The World Bank 2016a). With this fastest urbanization, Malaysia has only about 25% of rural population that performs food production by farming as their main economic activity. This means only about 25% of Malaysia is green. Urban centers such as Kuala Lumpur, Petaling Jaya, Klang, Johor Bahru, and Penang had reduced the greens of the environment, pose disaster, and bring massive traffic congestion to urban areas in Malaysia. Malaysians do not care about green and often just look for houses rather than food from agriculture. They have not experienced food shortages or

famine. They are complacent and only care for income generation. They must be reminded to reduce local man-made climatic changes.

10.6 The Sustainability of Agriculture

There are few ways to sustain agriculture. Firstly, the government must rationalize the priority in developing the agriculture and retaining farmers to stay in rural area through incentives. This either must include highland farming – Cameron Highlands – or the fishermen along the seashores. Secondly, it is the technology that matters. Technology is the application of science in daily life (Baharuddin 2013). Technology is the way of doing things that can make agriculture more productive and sustainable. The examples of technology are new varieties of crops that adapt to climate change and pest, good fertilizer, fertigation technique, and greenhouse cultivation of crops. Research and development is needed to develop new technology. Research and development (R&D) can be done in local public universities and organizations like Malaysian Agricultural Research and Development Institute (MARDI), Forest Research Institute Malaysia (FRIM), and Federal Agricultural Marketing Authority (FAMA). Research can generate new ideas to do things. Research in agriculture can be in the form of increasing yield of crops, producing crop varieties that adapt to climate change, and post-harvest product utilization. Just think of the uses of maize and soya bean in the United States. We must create new sources of wealth from Science and Technology (S&T) and R&D.

10.7 The Solutions to Sustain Agriculture

The first solution is public and private partnerships in sustaining agriculture for Malaysia. Government should have proper planning and programming on agriculture and assist the in situ farmers while developing agriculture sector. The government must not move people massively and carelessly to the urban areas. The farmers should be willing to cooperate with the government to develop the agriculture. The government and the farmers have the same objective, which is to develop agriculture and produce food to feed the nation. Government can plan good policies that can sustain the agriculture. Government can provide the basic environment for farming and give direction and focus to the direct agriculture development to produce food, feed, and fibers to the Malaysians. We must not engage in converting agricultural land to housing land at the present accelerated rate. Houses are not as basic as food for Malaysians.

Private sector refers also to the private enterprises that engage in agriculture. The private enterprises have capital, ideas, and time to develop agriculture. Capital is the man-made resource engaged in agricultural production, such as machine (Baharuddin 2013). The private enterprises need to generate ideas through funding in research to

increase yield of crops and use the available capital to engage in extensive scientific agriculture farming. The private enterprises also have more time to develop the agriculture compared to government which has many more agendas for the entire nation. Thus, the private enterprises should not be dependent on government to do research and development for agriculture and rural of Malaysia.

Education also plays an important role in sustaining the agriculture. Students in the schools and universities need to appreciate the nature of agriculture. Educators should educate the students on the importance of agriculture and inspire the students to participate in planting crops and to love the nature and agriculture. The students should be instrumental in preservation of trees and the conversion of agricultural land to housing. The students with farming background can be inspired by the educators to engage in farming rather than leaving agriculture as abandoning agriculture brings harm to the entire nation and the people, especially in the congested urban environment with limited work potential and high cost of living.

Farmers should also be educated by the extension service workers that engage directly with the farmers. The extension service workers would provide guide solutions to the problems faced by the farmers. For example, climate change has negative impacts on their crops. Thus, the extension service workers would bring the issue to the experiment station, such as Malaysian Agriculture Research and Development Institute (MARDI) located near to the rural area. The experiment station would develop good crops or seeds that adapt to climate change. The extension service workers would then distribute the adapted crops or seeds to the farmers and educate the farmers to plant in their farmland. Monitoring of the crop yields is required so that improvement measure can be done if there is limitation in the crop yields and seed adaptation to climate change.

10.7.1 Ways Forward for Malaysian Agriculture Under the Stress of Climatic Change

The four sectors in the Malaysian agriculture are:

1. Crops
2. Livestock
3. Fisheries
4. Forestry

Impact assessment needs to be done by the university experts. Universities in Malaysia can have experts in climate change department, including experts to do weather forecasting and climate forecasting to prepare farmers in every state in Malaysia. We have to develop our disaster risk management capabilities.

1. Improving our natural resources management to avoid exploitation of grassland, lake, rivers, mountains, and mineral resources that seriously affect in situ climatic conditions resulting in flooding, severe droughts, and reduced rainfall

2. Reforestation and conservation to minimize effects of climatic change
3. Preparedness of all parts of the Malaysian society
4. Development of biotechnology and preservation of biodiversity

10.7.2 Short-Term Strategies and Long-Term Strategies

The short term is 1 year or one season. There is not much Malaysia can do about it. But it does not mean Malaysia do not need to do anything. Malaysia needs to prepare the alternate crops and intensify R&D on staple crops. Malaysia needs to get alternate crops that are robust to climate change. Malaysia also needs to plan and prepare to “eat less food” and develop consumption habits as a result of climate change. The short-term strategies will need more discipline and control of the markets.

The long-term strategy for Malaysia is the need to do R&D and improve food storage, processing, and packaging technologies. Through R&D, Malaysia can produce better yielding crops that suit the Malaysian soils and climates and to climatic changes. United States had even worse change in climate change before due to the geographical location and industrialization. The United States faces typhoon, cyclone, drought, snow storms, floods, and strong winds. When climate change occurred in the United States, the cost of production in agriculture increased, and the land productivity was affected. These required more conservation efforts. Over time, through R&D, varieties of plants that are resistant to climate change were developed. For example, the United States produces drought-resistant wheat through R&D. The United States is more prepared with food technology. R&D in the United States had been around US\$479 billion or 2.8% of their gross domestic product (GDP) by purchasing power parity compared to Malaysia, equivalent to US\$9.7 billion or 1.3% of its GDP by purchasing power parity (UNESCO 2016). This means that Malaysia must be serious with R&D investments for the future in food technology to prepare for climatic changes. Malaysian food imports totalled RM45 billion in the year 2015. This shows Malaysia had not been serious in producing food locally or finding alternate crops to prepare for future changes of climatic. Therefore, Malaysia is very vulnerable to food crisis brought about by climatic change on agriculture. Malaysia can do a few things to prepare for climatic change. The things are:

1. Malaysia must improve food technology on agriculture
 - Malaysia can grow chillies and vegetables using hydroponic or fertigation techniques. The high import value of food indicates that Malaysia could face major crisis given her growing population and the negative impacts of climate change on agriculture.
2. The Malaysian society must inspire people to be farmers and not view agriculture as a poor and dirty business.
3. The Malaysian education system must be geared toward food self-sufficiency as an urgent agenda.

4. The political and government bureaucracies must put food and food security high on the budget, the plans, and research agenda.
5. Malaysia must adopt greenhouse technology and develop intensive agriculture when necessary.

10.7.3 Developing Drought-Resistant Crop

Drought-resistant crop can be developed to ensure continuous production even during drought season. For example, dry-seeded rice systems used in Bangladesh and the Philippines offer considerable economic advantages to Malaysian farmers and can ensure food security for the people. Malaysia can collaborate with the Thailand and Philippines universities in developing aerobic rice that grow in well-drained, non-puddled, and non-saturated soils. Aerobic rice can be grown in water-short irrigated lowlands (Bouman et al. 2007).

10.7.4 Development of High Productivity or High-Yielding Crop Varieties

Changes in rainfall and temperature might cause productivity losses in crops especially rice and vegetable production. For example, the drought in Malaysia can reduce the rice harvest in major granary areas in Kedah, Selangor, and Kelantan. Thus, research and development in developing high productivity rice should be intensified by local institutions including the public universities. In Malaysia, the only agriculture university is Universiti Putra Malaysia (UPM). The agenda at UPM is typical modern university, quite away from the sunset agriculture. This is not enough. Malaysia should send researchers and academicians to Thailand universities to learn rice production techniques. Thailand has good agriculture universities such as Thammasat University, Kasetsart University, and Srinakharinwirot University. Malaysia can learn the plant production and animal technology, such as from plant tissue culture, seed technology, and modern plant propagation in various institutions in Thailand under the umbrella of ASEAN and perhaps bilateral arrangements involving Thailand and Malaysia directly.

10.7.5 Land Conservation and Management

Land conservation is needed to prevent erosion and maintain fertility of soil. Research on land use is needed to understand the information on soil. Without information of soil use, Malaysia cannot do much in terms of policy to prevent erosion,

planting of crops, and to maintain fertility of the soil. Land is very important to agriculture and food production. If there is no land, there is no crops. Land or soil must be fertile to encourage plant growth. Thus, research on soil nutrients is needed to understand the suitability of soil to plant growth. Farmers and related stakeholders are responsible for maintaining adequate soil fertility for good plant growth. This must be complemented by fertilizers. Human waste and animal waste such as chicken dung are important soil conditioners to maintain soil fertility for good plant growth. Understanding the ecology of plant is crucial to agricultural sustainability and address the issue of climate change. Research effort on plant pest and disease management is also left behind in Malaysia. These issues will be important to the future of foods and food security in Malaysia.

10.7.6 Fishery Sector Preparation

There are a few ways in which the fishermen can do. Firstly, the fishermen must understand the climatic and weather forecasts before going out to the sea. If the weather forecast shows that the sea is rough and stormy, the fishermen should not venture out to the sea. The weather forecasts are reported by the Malaysian broadcasting companies. Climatic changes imply a warmer ocean, which could affect fish habitat. There is a need to develop and intensify the rearing of fish in cage. The fishermen can perform some fishery-related activities such as net mending, processing fish sauce, and backyard catfish raising to improve efficiency in the fishery sector. The funding and technical advice given by the Malaysian Fisheries Development Board (Lembaga Kemajuan Ikan Malaysia) must be updated and expanded. The first step must be intensified.

10.7.7 Assessment of Risk, Vulnerability, and the Welfare of the Fishermen

The risks in fisheries include risk from climate change and risk from overcapacity (Pomeroy 2012; Heenan et al. 2015). Overcapacity could be caused by the people's poverty and the government policies to give subsidies to build bigger boats for catching more fish. Heenan et al. (2015) show that protecting the habitat for fish to grow is a way to improve resilience of the sector to climate changes and increase economic returns from fisheries. Sarawak has a good preparation way to rebuild fish stocks since 1984. The Malaysian government has allocated 4400 artificial reefs from year 1984 to year 2016 to provide breeding grounds for the fish and expanding the fish population. We need more efforts in fish cage culture, freshwater fishery, and the brackish water fish capacity. We can and must learn from all others in these

issues especially from Thailand and the United States. The conservation efforts of the United States in crab and shrimp can be useful.

10.7.8 Proper Planning on the Coastal Development

There should be a proper planning on the coastal development so that any development projects near the coastline such as oil-drilling facilities and building tourism chalets would not bring erosion to the land bank and pollutes the river. Consultation between project planners and the fishermen is needed before the project is launched. Project managers must know the social, sciences, management, and environmental conservation costs brought to the fishermen because they are the most direct victim of the coastal development projects. Co-management of fisheries is needed to ensure the welfare of the stakeholders involved directly and indirectly in any development is protected. These issues also need scientific knowledge of fish and plant ecology.

10.7.9 Forest Sustainability

The government must apply laws and regulations to stop rapid or accelerated deforestation. Trees are important as they consume carbon dioxide (CO₂) and supply oxygen to human beings and prevent soil erosion by holding the soil and soil water. Trees also prevent flooding that results in climate change by absorbing excess water in the soil. Thus, trees must not be simply chopped off to make way for development project and urbanization. Proper planning of land for tree plantation must be carried out to add more trees in addition to the regular reserved forests. Every person must be responsible for the environment, the trees, and the jungles. Government can encourage and inspire reforestation in the rural area. Forest provides shade for the people and absorb the sun energy. Thus, forest can reduce the negative impacts from climate change, especially overheating from sunrays. Replant of forest needs to be funded by government and the big enterprises who talk about corporate social responsibility (CSR). However, good education system should encourage voluntarism and philanthropy of the Malaysians. These must be embedded in the schools and university curriculum.

10.7.10 Strategies for Protecting Livestock

Livestock is more vulnerable to climate changes compared to crops. We can adjust crops easily to prepare for climate change. Crops for food are short-term period, ranging from 1 month to 3 months to see the production, and thus easily adjustable. On the other hand, livestock is difficult to be adjusted to climate changes. Unless

Malaysia has breeding program, the adjustments cannot be fast. Malaysia is in urgent need of livestock to provide meat and milk for the people. The self-sufficiency rate for milk in Malaysia is 7%, whereas for beef is about 24% (Department of Veterinary Malaysia 2015). Therefore, strategies for livestock especially meat and milk production alternatives are needed. Malaysia needs effective land use management and town planning for livestock to produce meat and milk to feed the people. Malaysia needs to have adequate grasslands and feedlots for the cow to graze in the field. Malaysia must not mismanage the land resources for building houses alone. We must not have all the flatlands and housing in Malaysia.

10.8 Conclusion

Agriculture is very important to Malaysia because agriculture provides food and employment to the Malaysians. However, agriculture and climate are interdependent. Plants and animals depend on the climatic factors such as the soil, sun, and water to grow. Destroys of the climatic factors may impede the growth of plants and animals. Climatic change can be caused by man-made and nature-made. Climatic change is signified by the increase in temperature, increase acidity of the soil and water, and increase of rainfalls that may have adverse effects on the plants and animals. Thus, human beings must understand the biological production process of agriculture to minimize the adverse effects of climatic change on agriculture. There are short-term and long-term strategies to sustain agriculture. The short-term strategies are making the Malaysian society more disciplined under-controlled market conditions. The examples of short-term strategies are Malaysian society must not engage in converting agricultural land to housing at the present accelerated rate, reduce the rate of cutting down forests and flattening mountains for urbanization development, and proper planning on the coastal development. The long-term strategies are Malaysia needs to do research and development (R&D) in food production technology to prepare for climate changes and also to improve her food storage, processing, and packaging technology.

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