# Climate Variability and its Impact on the Palm Oil Industry

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**ABSTRACT**

*Located between the Indian and Pacific Oceans, Malaysia is exposed to changes in climate variability, namely, the* El Niño *and* La Niña *phenomena. These two complex weather patterns result from variations in the ocean temperatures of the equatorial Pacific. The occurrence of the so-called* El Niño*-Southern Oscillation (ENSO) event has a notable impact on the amount of rainfall in Malaysia. However, the magnitude of the impact depends on the intensity of the event. Additionally, the occurrence of the ENSO event also influences the production of crude palm oil (CPO) as rainfall is one of the key requirements for oil palm cultivation. This article describes the development of the ENSO event and analyses its impact on the palm oil industry in Malaysia.*

**Keywords:** *El Niño*, *La Niña*, ENSO, FFB yield, crude palm oil.

## INTRODUCTION

The oil palm industry is important to the Malaysian economy. In 2015, palm oil became the world's top vegetable oil with a record production of 62.79 million tonnes, accounting for 35.1% of the global vegetable oil output (MPOB, 2016). The three largest producers of palm oil are Indonesia, Malaysia and Thailand, with the palm oil output from Malaysia in 2015 standing at 19.96 million tonnes, or 31.8% of the world's total palm oil production. Palm oil is an important commodity, generating a significant amount of revenue for the Malaysian economy. According to the Malaysian Department of Statistics, the export earnings from palm oil in 2015 totalled RM 40.1 billion, equivalent to 5.1% of Malaysia's total exports (Malaysia External Trade Development Corporation, 2016).

Palm oil is one of the major edible oils traded in the global oils and fats market. Palm oil and its products have been extensively

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used in the food as well as the manufacturing industries. Moving forward, the global demand for palm oil is expected to remain strong, underpinned by the increasing world population and its attractive price relative to those of other oils. In terms of supply, the oil palm is known to be the most efficient producer of oil compared with other oil crops. However, palm oil production is strongly influenced by the weather pattern. The occurrence of the *El Niño* event (prolonged hot and dry weather), or the *La Niña* (cooler temperature and normally associated with heavy rainfall), has proven to significantly affect oil palm production. However, the impact of this climate variability on the Malaysian palm oil industry depends on the intensity of the events.

The disruptions resulting from these extreme weather conditions are significant to the Malaysian palm oil industry. In this study, we analysed the impact of climate variability on palm oil production. This study also sought to comprehend climate variability and the indicators as they are important for assessing the potential impact and for influencing the potential adaptation strategies to reduce the impact of these phenomena.

## DEFINITION OF WEATHER, CLIMATE VARIABILITY AND CLIMATE CHANGE

According to the Australian Bureau of Meteorology, there is a distinction between weather, climate variability and climate change. Weather describes the current atmospheric conditions such as rainfall, temperature and wind speed at a particular place and time. Weather changes from day to day. On the other hand, climate variability describes short-term changes in climate that take place over months, seasons and years. Climate is the average pattern of weather for a particular place over several decades. Examples of climate variability are the *El Niño*-Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). Climate change refers to events which happen over centuries, such as global warming. The year-to-year variability in the climate of the Pacific is influenced by ENSO. This oscillation leads to variability in rainfall, temperature, winds, cyclone activity, ocean currents and sea levels (pacificclimatechangescience.org). The ENSO impact on Malaysia, in particular, will be discussed further in this article.

## OVERVIEW OF THE MALAYSIAN PALM OIL INDUSTRY

With Malaysia located near the equator, her climate is categorised as equatorial, being hot and humid throughout the year. With a total land area of 329 847 km², agricultural activities in Malaysia have been steadily expanding. In the early 1960s, returns from the oil palm business were found to be better than that of rubber. As a result, the government of Malaysia aggressively promoted the palm oil industry. Expansion of this industry during the 1960s was in response to the government's diversification policy, seeking to reduce the country's dependency on natural rubber, which had been in the doldrums due to stiff competition from synthetic rubber.

The Malaysian oil palm industry has been around for more than 50 years, and in 2015, about 5.6 million hectares of land are planted with oil palm; this is about 17.1% of Malaysia's total land area. Previously, Malaysia was the world's largest producer of palm oil. However, in 2007, due to the rapid growth and expansion in oil palm planting, Indonesia overtook Malaysia to gain the world's top spot. In 2015, Indonesia exported 25.9 million tonnes of palm oil, 17.7% higher than the total palm oil exports from Malaysia (MPOB, 2016).

### Current Development

In 2015, the oil palm planted area in Malaysia reached 5.64 million hectares, an increase of 39.3% against that of 2005. Out of this planted area, 86.1% consisted of mature palms aged three years and above, while the remaining 13.9% were immature oil palm areas. With a processing capacity of 108 396 400 t fresh fruit bunches (FFB) and an oil extraction rate (OER) of 20.46%, crude palm oil (CPO) production in Malaysia in 2015 was 19.96 million tonnes, a 33.4% increase from 14.96 in 2005. The industry is dominated by large plantation companies (private and government-linked companies) which hold 61.1% of the total planted area which show a growing level of integration along the value chain. Significant shares in the oil palm planted area are under government schemes and independent smallholders, accounting for 6.2% and 15.7% of the total area, respectively.

Due to its significant contribution to the Malaysian economy, the government has identified the palm oil industry as one of the 12 National Key Economic Areas to spearhead its economic transformation programme, the goal being to transform Malaysia into a developed nation by 2020. Due to limited land availability for expansion, the growth strategy for the palm oil industry is to focus on increasing the FFB yield and CPO production. This is to be implemented through the genetic improvement and a consistent replanting programme.

Apart from expanding the upstream business, the government also aggressively promotes the expansion of downstream activities, such as the processing of foods, oleo derivatives, phytonutrients and biodiesel. Currently, Malaysia has yet to capture the full potential of existing downstream opportunities. In 2015, only about 30.0% of Malaysia's palm oil products are exported as downstream products as opposed to 73.0% which are exported as upstream products either in the crude or processed form (MPOB, 2016).

## Oil Palm Cultivation and Requirements

In line with the population growth around the world, the global demand for oils and fats is also expected to register steady growth. On this premise, the business prospects for the palm oil industry remain intact. As a consequence, there is still strong interest in oil palm cultivation. However, growing oil palm is not just a matter of picking the fruit. It requires huge capital investment and proper land preparation. Apart from these, land selection, choice of planting material, technical management and environmental management are some of the key factors that need to be given attention in oil palm cultivation.

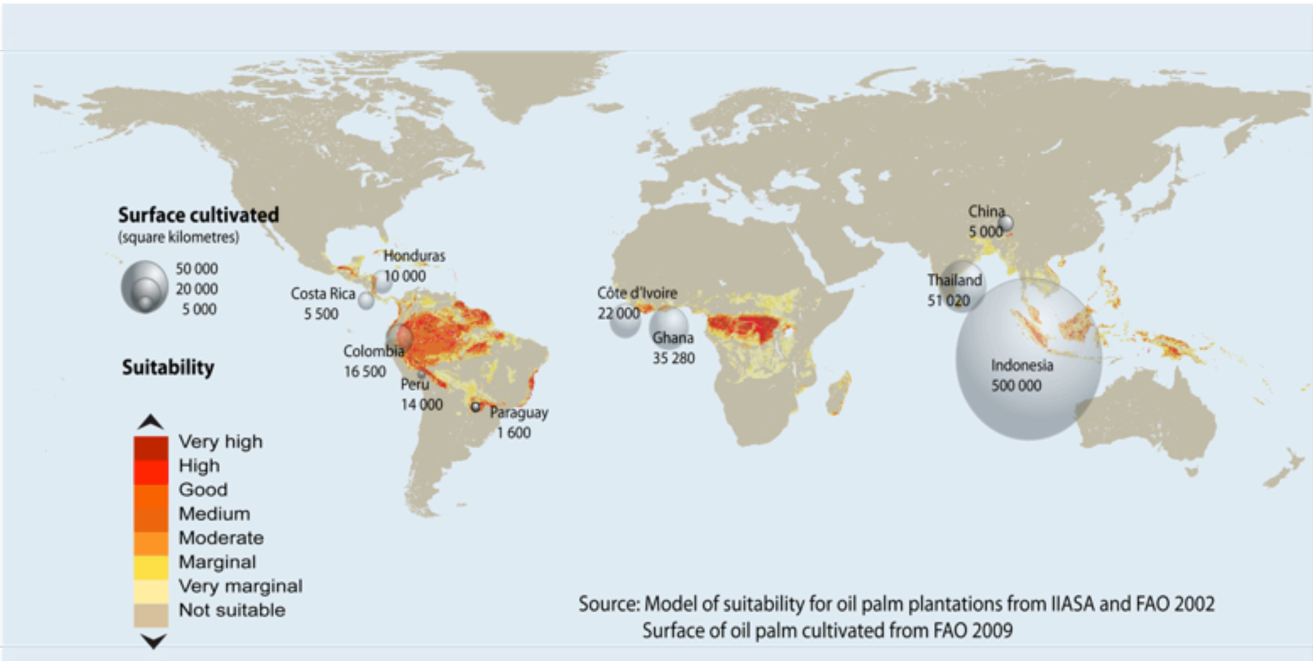
As a tropical plant, the oil palm requires an evenly distributed annual rainfall of 1500 - 2000 mm or more, without a defined dry season. Best oil palm yields are obtained in those places where there is a maximum average temperature of 29°C - 33°C and a minimum average temperature of 22°C - 24°C. The crop requires constant sunlight of at least 5 hr per day for better oil palm yield (Norman *et al.*, 2014). Due to these requirements, the palms are suited to be cultivated only in the tropical areas of Asia, Africa and South America (*Figure 1*).

About 90% of the world's total oil palm production comes from South-east Asian region, *i.e.* Indonesia, Malaysia and Thailand. Hence, any disruption in the production in any of these countries arising from adverse weather conditions in particular would significantly influence the supply of the world's vegetable oils.

## INTRODUCTION TO THE *EL NIÑO* AND *LA NIÑA*

Located within the Asia Pacific, Malaysia, Indonesia and Thailand are exposed to a range of climate conditions and extreme events. The region's climate is also influenced by the variability associated with the ENSO which gives rise to cyclic droughts and extreme sea levels.

The climate variability in the Pacific region is driven by changes in circulation, winds, rainfalls and ocean surface temperatures. This variability consequently leads to the development of the *El Niño* and *La Niña* events. *El Niño* and *La Niña* are the opposite phases of ENSO cycle, a scientific term that describes the fluctuations in temperature between the ocean and the atmosphere in the east-central equatorial Pacific. This oscillation is normally identified by




Source: United Nations Environment Programme (http://na.unep.net/).

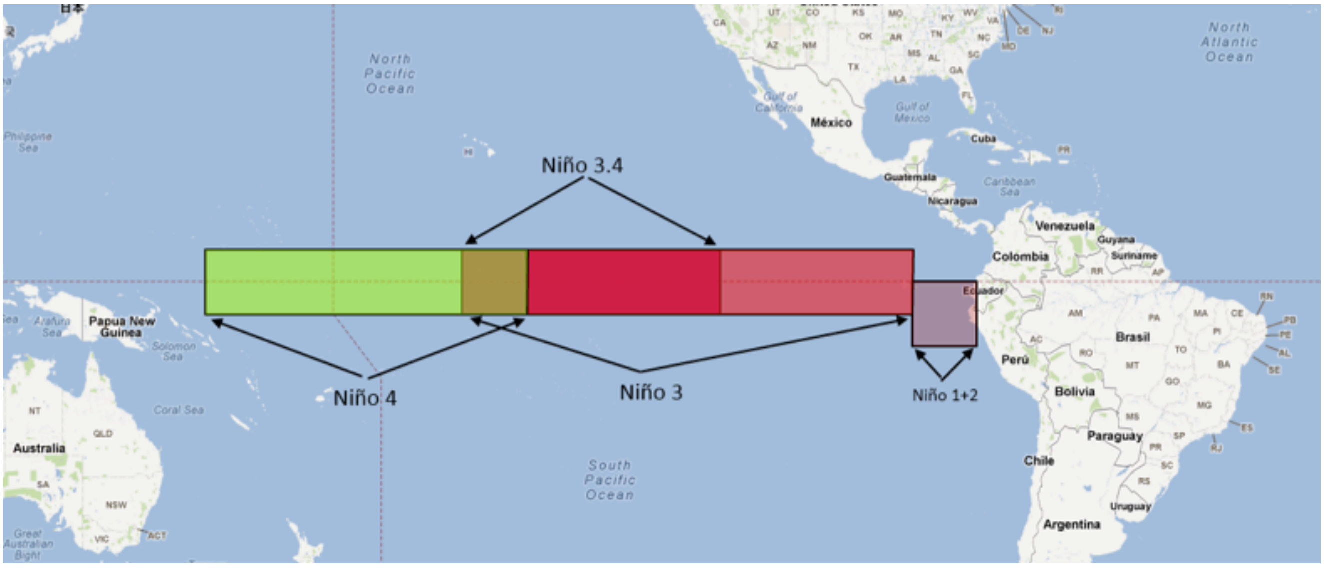
*Figure 1. Areas suitable for oil palm cultivation.*

the sea surface temperature (SST) in the Niño region (*Figure 2*).

In an *El Niño* event, SST in the western equatorial Pacific is warmer than the normal central and eastern equatorial Pacific SST, and *vice versa* during the occurrence of *La Niña* (western Pacific SST cooler than the normal central and eastern equatorial Pacific SST). When temperatures in the ENSO region of the Pacific are near average, it is known as ENSO neutral, meaning that the oscillation is neither in a warm nor cool phase.

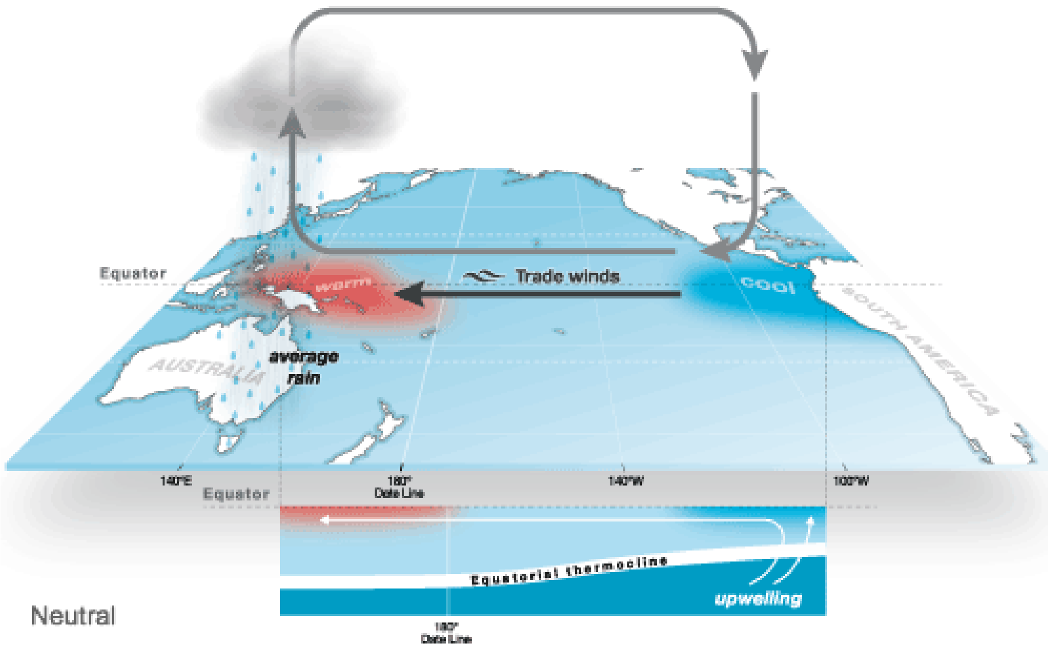
Under the normal conditions of ENSO, the waters of the western Pacific are very warm. This creates rising moisture which produces massive thunderstorms and brings abundant rain to Indonesia and the rest of South-east Asia. It also contributes to an air circulation pattern that takes dry air eastwards and drops it on the west coast of South America. The air completes the loop as it moves westwards across the Pacific Ocean. This strong westward wind pushes the surface water to the west. Along the west coast of South America, cold water from the deep ocean then rises to replace the water moving to the west (*Figure 3*).

Every two to seven years, an *El Niño* event occurs. During an *El*




Source: http://www.shapingtomorrowsworld.org

*Figure 2. The* Niño *region.*



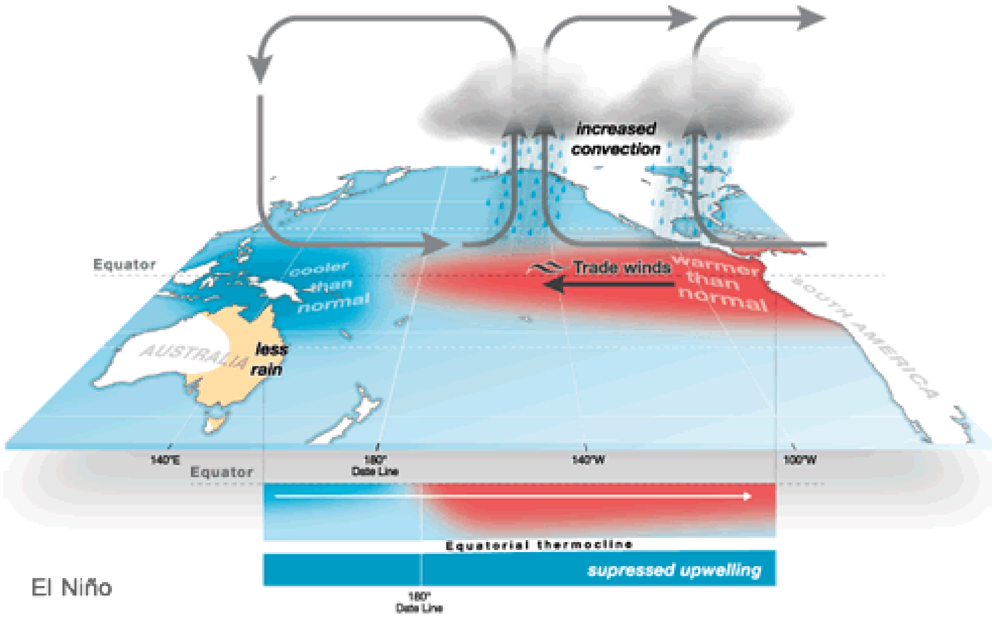

Source: Australian Bureau of Meteorology.

*Figure 3. Normal* El Niño-*Southern Oscillation (ENSO).*

*Niño* event, trade winds weaken or may even reverse, allowing the area of warmer than normal water to move into the central and eastern tropical Pacific Ocean. Thunderstorms now occur towards the east. This, along with changes in the position of the jet stream brings these violent Pacific storms to the west coast of South America and USA. The air circulation pattern is now reversed, bringing drought conditions to Indonesia/Malaysia and to Australia (*Figure 4*).

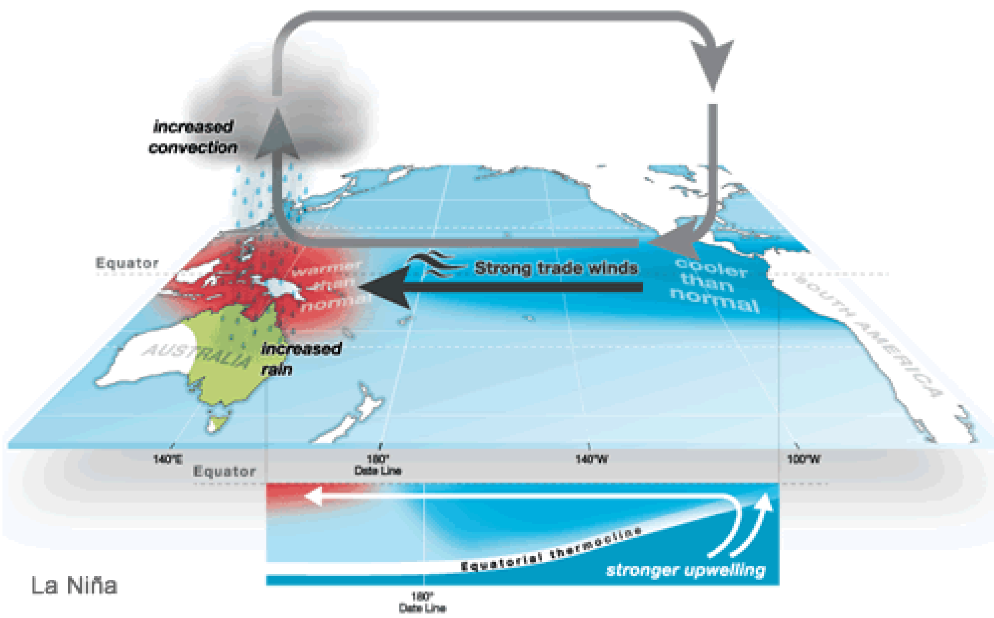
Meanwhile, for the *La Niña* episode which may, but does not always, follow an *El Niño*, the cycle returns to an exaggeration of normal conditions. This brings greater than average precipitation to the western Pacific and drought conditions to South America. During a *La Niña* event, the Walker Circulation[1] intensifies with greater convection over the western Pacific and trade winds are stronger (*Figure 5*).

[1] The Walker Circulation is named after Sir Gilbert Walker, the scientist who first recognised a semi-regular pattern of high and low rainfall (and hence feast and famine) over India.




Source: Australian Bureau of Meteorology.

*Figure 4.* El Niño-*Southern Oscillation (ENSO) during an* El Niño *event.*




Source: Australian Bureau of Meteorology.

*Figure 5.* El Niño-*Southern Oscillation (ENSO) during a* La Niña *event.*

## ENSO TRACKER

There are various tools and techniques to monitor and forecast changes in the Pacific Ocean and the impact of those changes on global weather patterns. According to the National Oceanic and Atmospheric Administration of the United States (NOAA), *El Niño* can be detected by many methods, including satellites, moored buoys, drifting buoys, sea level analyses and expendable buoys. Many of these ocean-observing systems are part of the Tropical Ocean Global Atmosphere (TOGA) programme, and are now evolving into an operational ENSO observation system.

The Australian Bureau of Meteorology set a few criteria for tracking the development of an *El Niño* or *La Niña* event. To determine the early stage development of *El Niño* and *La Niña*, any three of the following criteria need to be satisfied.

### Sea Surface Temperature

Monitoring of the ENSO conditions primarily focuses on SST anomalies in the ENSO region. When tracking the development of an *El Niño* and *La Niña* event, *Niño* 3.4 SST anomalies are averaged over three months ending with the current month, and that value is called the Oceanic *Niño* Index (ONI).

### Oceanic *Niño* Index

To predict the *El Niño* and *La Niña* phenomenon, the majority of the climate centres monitor the five consecutive values of ONI (three-month running mean SST anomalies) in the *Niño* 3.4 region. If ONI exhibits warm or cool phase conditions for at least five consecutive values, it officially becomes an *El Niño* or *La Niña* event. The threshold for ONI to be classified as warm and cold phases is +/- 0.5°C. *Table 2* shows the trend of ONI values in the *Niño* 3.4 region from December 1990 to January 2016.

Based on the above ONI values, there have been about eight *El Niño* and five *La Niña* events within the 25-year period (1990-2015). The most severe *El Niño* occurrence was in 1997 when the ONI values hovered between +2.0 and +2.3 from August 1997 to January 1998, while the most severe *La Niña*

**TABLE 1. OCEAN *NIÑO* INDEX (ONI) VALUES, 1990-2016**

| Year | DJF | JFM | FMA | MAM | AMJ | MJJ | JJA | JAS | ASO | SON | OND | NDJ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1990 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.3 | 0.4 | 0.4 |
| 1991 | 0.4 | 0.3 | 0.2 | 0.2 | 0.4 | 0.6* | 0.7* | 0.7* | 0.7* | 0.8* | 1.2* | 1.4* |
| 1992 | 1.6* | 1.5* | 1.4* | 1.2* | 1* | 0.8* | 0.5* | 0.2 | 0 | -0.1 | -0.1 | 0 |
| 1993 | 0.2 | 0.3 | 0.5 | 0.7 | 0.8 | 0.6 | 0.3 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 |
| 1994 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.6* | 0.9* | 1* |
| 1995 | 0.9* | 0.7* | 0.5* | 0.3 | 0.2 | 0 | -0.2 | **-0.5** | **-0.7** | **-0.9** | **-1** | **-0.9** |
| 1996 | **-0.9** | **-0.7** | **-0.6** | -0.4 | -0.2 | -0.2 | -0.2 | -0.3 | -0.3 | -0.4 | -0.4 | -0.5 |
| 1997 | -0.5 | -0.4 | -0.2 | 0.1 | 0.6* | 1* | 1.4* | 1.7* | 2* | 2.2* | 2.3* | 2.3* |
| 1998 | 2.1* | 1.8* | 1.4* | 1* | 0.5* | -0.1 | -0.7 | **-1** | **-1.2** | **-1.2** | **-1.3** | **-1.4** |
| 1999 | **-1.4** | **-1.2** | **-1** | **-0.9** | **-0.9** | **-1** | -1 | **-1** | **-1.1** | **-1.2** | **-1.4** | **-1.6** |
| 2000 | **-1.6** | **-1.4** | **-1.1** | **-0.9** | **-0.7** | **-0.7** | -0.6 | **-0.5** | **-0.6** | **-0.7** | **-0.8** | **-0.8** |
| 2001 | **-0.7** | **-0.6** | **-0.5** | -0.3 | -0.2 | -0.1 | 0 | -0.1 | -0.1 | -0.2 | -0.3 | **-0.3** |
| 2002 | -0.2 | -0.1 | 0.1 | 0.2 | 0.4 | 0.7* | 0.8* | 0.9* | 1* | 1.2* | 1.3* | 1.1* |
| 2003 | 0.9* | 0.6* | 0.4 | 0 | -0.2 | -0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 |
| 2004 | 0.3 | 0.2 | 0.1 | 0.1 | 0.2 | 0.3 | 0.5* | 0.7* | 0.7* | 0.7* | 0.7* | 0.7* |
| 2005 | 0.6* | 0.6* | 0.5* | 0.5* | 0.4 | 0.2 | 0.1 | 0 | 0 | -0.1 | -0.4 | -0.7 |
| 2006 | -0.7 | -0.6 | -0.4 | -0.2 | 0 | 0.1 | 0.2 | 0.3 | 0.5* | 0.8* | 0.9* | 1* |
| 2007 | 0.7* | 0.3 | 0 | -0.1 | -0.2 | -0.2 | -0.3 | **-0.6** | **-0.8** | **-1.1** | **-1.2** | -1.3 |
| 2008 | **-1.4** | **-1.3** | **-1.1** | **-0.9** | **-0.7** | **-0.5** | -0.3 | -0.2 | -0.2 | -0.3 | -0.5 | -0.7 |
| 2009 | -0.8 | -0.7 | -0.4 | -0.1 | 0.2 | 0.4 | 0.5* | 0.6* | 0.7* | 1* | 1.2* | 1.3* |
| 2010 | 1.3* | 1.1* | 0.8* | 0.5* | 0 | **-0.4** | **-0.8** | **-1.1** | **-1.3** | **-1.4** | **-1.3** | **-1.4** |
| 2011 | **-1.3** | **-1.1** | **-0.8** | **-0.6** | -0.3 | -0.2 | -0.3 | **-0.5** | **-0.7** | **-0.9** | **-0.9** | **-0.8** |
| 2012 | **-0.7** | **-0.6** | **-0.5** | -0.4 | -0.3 | -0.1 | 0.1 | 0.3 | 0.4 | 0.4 | 0.2 | -0.2 |
| 2013 | -0.4 | -0.5 | -0.3 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 | -0.2 | -0.3 |
| 2014 | -0.5 | -0.6 | -0.4 | -0.2 | 0 | 0 | 0 | 0 | 0.2 | 0.4 | 0.6 | 0.6 |
| 2015 | 0.5 | 0.4 | 0.5* | 0.7* | 0.9* | 1* | 1.2* | 1.5* | 1.8* | 2.1* | 2.2* | 2.3* |

Note: *Numbers indicate the *El Niño* phase while numbers in bold indicate the *La Niña*.
Source: http://www.cpc.ncep.noaa.gov/

phenomenon for the past 25 years occurred in 1999, following after the *El Niño* event. Indication of the *El Niño* and *La Niña* events by the ONI values is more or less in line with the readings of the Southern Oscillation Index anomalies.

**Southern Oscillation Index**

The Southern Oscillation Index, or SOI, is a standardised index based on the observed sea level pressure differences between Tahiti (representing the eastern Pacific) and Darwin, Australia (representing the western Pacific) (*Figure 6*). It measures the fluctuations in air pressure occurring within the *Niño* region and gives an indication of the development and intensity of the *El Niño* or *La Niña* event in the Pacific Ocean.

Sustained negative values of SOI below -7 (lasting for at least six months) often indicate *El Niño* episodes. These negative values are usually accompanied by sustained warming of the central and eastern tropical Pacific Ocean, a decrease in the strength of the Pacific trade winds, and a reduction in winter and spring rainfall over much of eastern Australia. Meanwhile, sustained positive values of SOI above +7 are typical of a *La Niña* episode. They are associated with stronger Pacific trade winds and warmer sea temperatures to the north of Australia. Waters in the central and eastern tropical Pacific Ocean become cooler during this time. Together these give an increased probability that eastern and northern Australia will be wetter than normal.

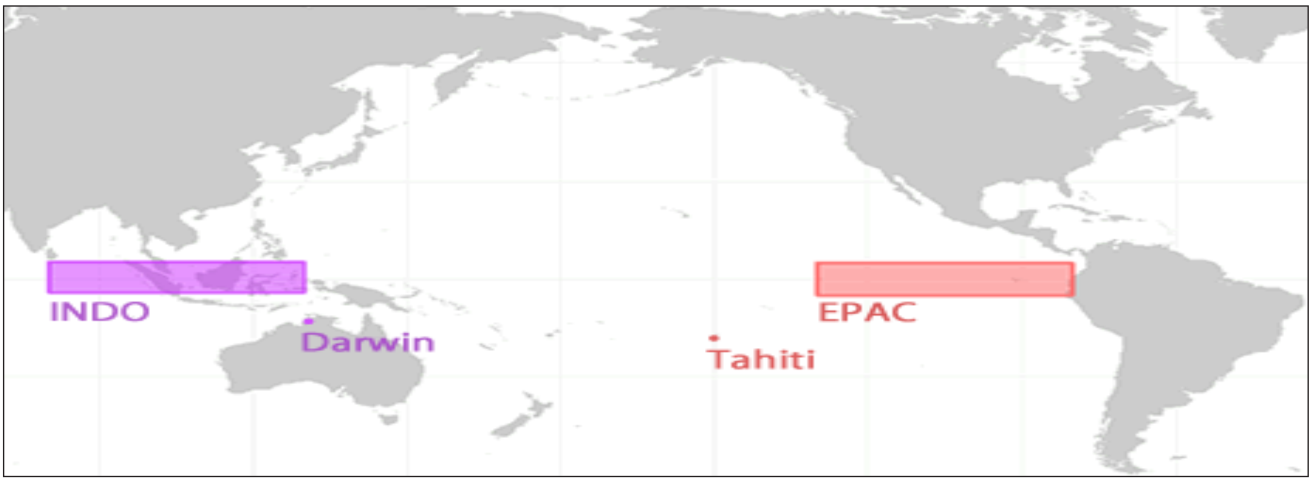
**THE IMPLICATION OF CLIMATE VARIABILITY ON MALAYSIA'S WEATHER PATTERN**

The occurrence of *El Niño* and *La Niña* disrupts the global weather patterns. However, their impact varies from place to place, depending on the intensity of the ENSO event. An ENSO event in general affects the variability of precipitation or the amount of rainfall in Malaysia. The current study utilised monthly rainfall data recorded by the Malaysian Palm Oil Board's (MPOB) stations all over Malaysia from 1990 to 2016, and data on monthly SST anomalies from NOAA. Analysis of these data showed that despite recording a low correlation of -17%, the Granger causality test shows that SST significantly influenced rainfall pattern in Malaysia (*Table 2*). A Granger causality analysis was carried out in order to assess whether SST has any potential predictability power on the amount of precipitation in Malaysia. This study employed the same data stream as an earlier analysis. The conclusion that can be drawn is that both SST and rainfall have a significant bidirectional causality. In this case, SST did influence the

**TABLE 2. PAIRWISE GRANGER CAUSALITY TESTS**

| Sample: 1990M01 2015M12 | | | |
|---|---|---|---|
| Null hypothesis: | Obs. | F-statistic | Prob. |
| SST does not Granger cause rainfall<br>Rainfall does not Granger cause SST | 310 | 2.84040<br>5.06784 | 0.0599*<br>0.006** |

Note: *And **indicate statistical significance at the 5% and 10% probability levels, respectively.




Source: www.climate.gov

*Figure 6. Tahiti and Darwin, Australia.*

amount of rainfall in Malaysia, and *vice versa*.

Analysis of the data showed that the effect of the ENSO events was more prominent in Sabah and Sarawak than in Peninsular Malaysia. The correlation coefficient between SST anomalies and the amounts of rainfall in Sabah, Sarawak and Peninsular Malaysia was -37%, -20% and -7%, respectively. The impact of the ENSO events on the level of precipitation in Malaysia was clearer during a severe ENSO episode such as in 1997/1998 (*Figure 7*). The correlation between SST and the amounts of rainfall in Sabah, Sarawak and Peninsular Malaysia was then -52%, -41% and -23%, respectively.

During the strongest *El Niño* of 1997-1998, Malaysia experienced a substantial decrease in rainfall, dropping more than 50% from the level of 200 mm in April 1997 to a low of 58 mm in February 1998. Subsequent to the *El Niño* event, Malaysia then experienced a *La Niña* phenomenon when the rainfall in Malaysia increased to 365 mm in December 1999. This was influenced by the decline in SST from a positive anomaly of 0.6°C in early 1998 to a negative anomaly of -1.67°C in early 1999.

The impact of the *El Niño* and *La Niña* events was more significant in east Malaysia (Sabah and Sarawak) than in Peninsular Malaysia. In the presence of a strong *El Niño* (October 1997 to March 1998), the rainfall over east Malaysia decreased by about 37% compared with that in Peninsular Malaysia which recorded a drop in rainfall by only 7% during the severe period of *El Niño*. The impact of *El Niño* and *La Niña* on Malaysia's weather depended on the magnitude of the ENSO event. A weak *El Niño* event normally had minimal impact on rainfall in Malaysia.

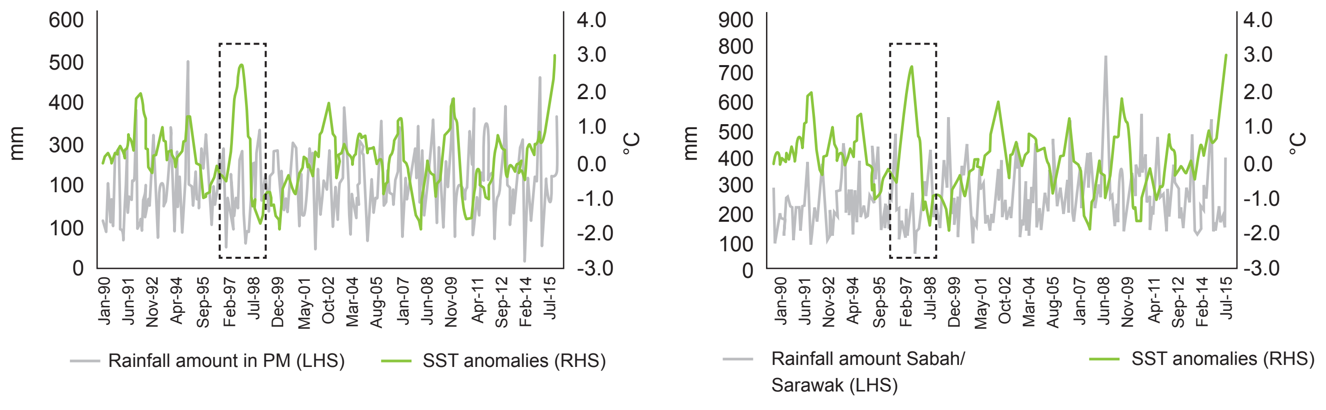
## THE IMPACT OF CLIMATE VARIABILITY ON OIL PALM

As the world's second largest producer and exporter, a consistent growth in palm oil production from Malaysia is important to avoid an acute shortage of palm oil globally. The growth and the yield of oil palm depend largely on the climatic characteristics of the environment. For oil palm, the occurrence of adverse weather conditions – *El Niño* or *La Niña* – does not directly or immediately affect the palms. Instead, it affects processes in an earlier growth stage of oil palm (*i.e.* frond production, sex ratio, extent of floral abortion, degree of survival of flowers after anthesis and bunch weight) (Verheye, 2010). These will consequently influence, and in turn will determine, oil palm yield.

Fundamentally, yield will be affected when the palms are exposed to stressful conditions – low soil moisture due to prolonged dry and hot weather conditions. It should be noted that ideally oil palm requires evenly distributed annual rainfall of 1500-2000 mm without a defined dry season, and preferably at least 100 mm each month. Rainfall below the average amount will disrupt the development of the fruit bunches and affect production in the 10 to 24 months following the event (Harun *et al.*, 2010).

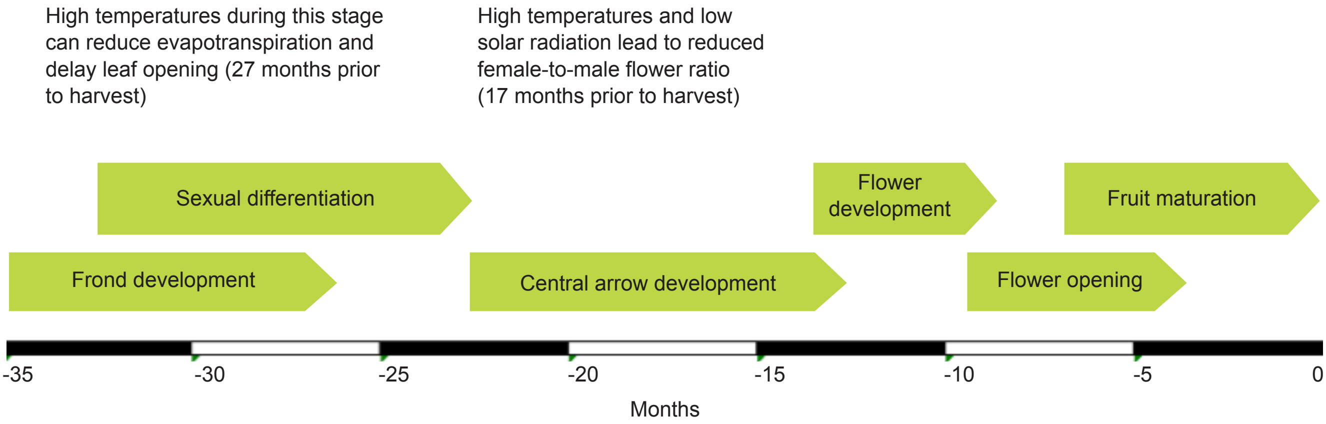
*Figure 8* summarises the major phenological growth stages of oil palm that are responsive to the changes in climatic conditions. As the flowering process happens at the base of each leaf, the rate of leaf production will determine the number of the fruit bunches. Therefore, any interruption during frond development (leaf opening) will consequently affect the FFB yield in the subsequent 28 months. As only the female inflorescences will develop into large and heavy fruit bunches, lower production of female inflorescences will also lead to lower FFB production.

*Figure 9* exhibits the correlation between FFB yield and rainfall pattern. The substantial drop in rainfall during the strong *El Niño*



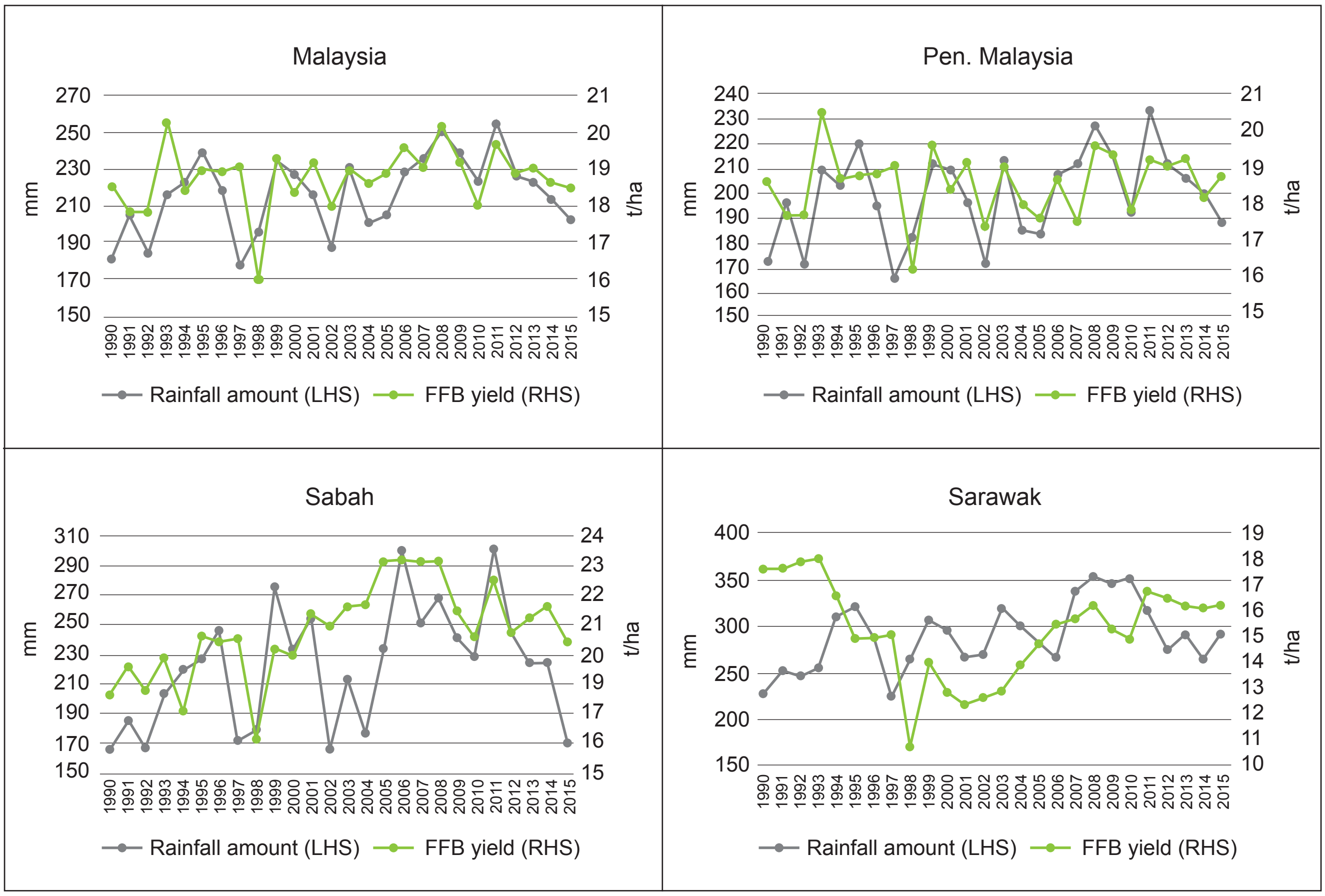

Source: MPOB (2016); National Oceanic and Atmospheric Administration.

*Figure 7. Correlation between rainfall amount (in mm) and sea surface temperature (SST )anomalies, 1990-2015.*




Source: Shanmuganathan and Narayanan (2012).

*Figure 8. Oil palm life cycle and approximate timing of processes related to fruit bunch development.*




Source: MPOB (2016).

*Figure 9. Fresh fruit bunch (FFB) yield in relation to rainfall, 1990-2015.*

event in 1997 significantly reduced FFB yield in Malaysia. The charts also show that the impact of *El Niño* was more prevalent in east Malaysia than in Peninsular Malaysia. In 1997, rainfall in Sabah and Sarawak decreased by 30.2% and 21.9% year-on-year, respectively, while in Peninsular Malaysia it dropped by only 14.8% year-on-year. Lower rainfall in 1997 caused FFB yield in the following year to drop by 18.7%, 28.6% and 14.6% over that of the previous year for Sabah, Sarawak and Peninsular Malaysia, respectively. A higher amount of rainfall is good for oil palm production. The occurrence of *La Niña* following an *El Niño* episode normally caused FFB yield to increase sharply. Despite the adaptability of oil palm to a high higher amount of rainfall, continuous water-logging will negatively affect the growth of oil palm. Prolonged water-logging in the estates hinders the respiration of oil palm roots and consequently kills the palms. Additionally, an excessive amount of rainfall also causes flooding. This will interrupt the evacuation process of FFB from estate to mill, raise the moisture content in the fruitlets, and consequently lower oil extraction rate.

Although oil palm needs a lot of water, water-logging in the estate for more than a few months may cause damage to the palms. With prolonged water-logging, not only the roots are unable to respire but the uptake of nitrogen is also limited, which in turn affects the growth and the yield of oil palm (Corley and Tinker, 2003). Besides, water-logging in oil palm estates disrupts harvesting and collection activities. The logistics of transporting FFB from estate to mill is disrupted during floods, causing FFB to become overripe and rotten, and consequently depressing both FFB yield and CPO production. This can be seen from the five-year average FFB yield pattern which normally declines in November to December (*Figure 10*) due to heavy rainfall.

## STRATEGIES TO REDUCE THE EFFECT OF CLIMATE CHANGE ON OIL PALM PRODUCTION

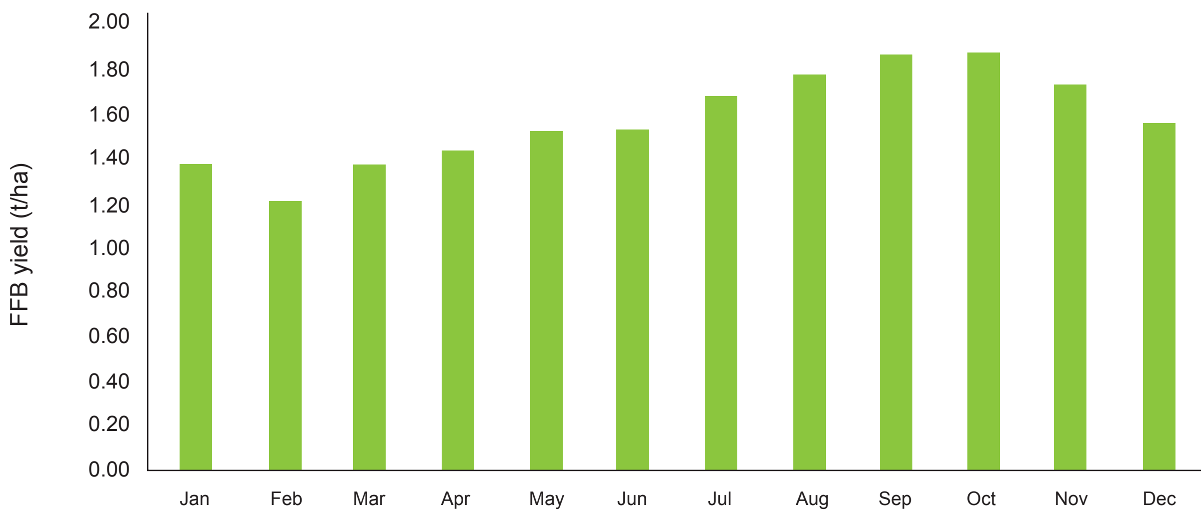
The impact of climate change on the Malaysian palm oil industry is evident. As one of Malaysia's major socio-economic drivers, a significant drop in oil palm yield resulting from adverse weather conditions not only affects the listed oil palm plantation companies, but also severely affects the smallholders. Due to its important contribution towards the development of the socio-economic structure in Malaysia, better adaptation strategies need to be formulated to reduce the climatic impact and to maintain stability in palm oil production. The following are some recommended actions that can be carried out to alleviate the potential negative effect of climate change.

### During *El Niño*

To reduce the effect of *El Niño* on oil palm yield, activities such as replanting need to be delayed as the lack of rain can affect seedling establishment and growth. During planting, the seed should be kept moist, cool and in the shade at all times. Very hot, dry and windy weather may cause damage to the seed. As the palms need a lot of water, water conservation in the field should be strongly advocated. Good water management helps the palms reach their optimum growth.

Another issue that raises concern among the environmentalists during the *El Niño* event is haze which is caused by fires in peatland where there are oil palm plantations. To protect and reduce the risk of the peat from catching fire, the water-table should be raised and maintained at a high level (<50 cm from the peat surface) as soon as possible before the dry months start. Additionally, the use of tube wells should also be explored to tap water from underground aquifers. For the nursery and irrigation purposes, planters are also encouraged to store water in ponds or to construct small dams to capture as much rain as possible.

Apart from that, in order to protect the palms against severely dry periods, planters should practise mulching. Mulching of




Source: MPOB (2016).

*Figure 10. Five-year average fresh fruit bunch (FFB) yields by month in Malaysia.*

Source: http://www.hiwtc.com

*Figure 11. Mulching of oil palm.*

oil palm is essential to conserve moisture as well as to control weeds (*Figure 11*). Mulching can be done with dried oil palm fronds, male inflorescences, coconut husks and empty oil palm bunches from the mills. In the estate, all the pruned fronds are heaped in between two adjacent rows of oil palm, and will act as mulch. Besides conserving moisture, mulching materials help to maintain soil temperature, add organic matter and nutrients, mainly potassium, to the soil, as well as improve the physical and biological properties of the soil.

**During *La Niña***

To ensure that water does not stagnate in the field, a good water management system is very much required. A proper drainage system is important to drain out excess water and to help the oil palm roots proliferate the entire soil profile rather than being restricted to only the upper layer of the soil. Hence, waterways in oil palm estates should be well maintained and kept clear of any blockages in the form of vegetative wastes (*Figures 12* and *13*).

According to the guidelines on oil palm plantation development set by the State Environmental Conservation Department (ECD), Sabah, removal and disposal of blocking materials should be incorporated into the plantation work schedule. This will help to ensure smooth conveyance of surface water and prevention of flash floods on site. As far as possible, stream crossings should be provided where natural waterways within the oil palm plantation are affected. This approach will prevent the occurrence of flash floods as well as ensure smooth conveyance of surface runoff.

For oil palm estates near to natural water catchment areas (*e.g.* river, lake), it is important for the planters to maintain the riparian reserves. River reserves serve as natural filters for surface runoff from the plantation areas. The reserves also play a major role in protecting the banks of the waterways from channel erosion. Additionally, river reserves within the plantation area provide evacuation corridors and a sanctuary for fauna, preventing

Source: State Environmental Conservation Department (2012).

*Figure 12. Vegetative wastes blocking a waterway.*

*Figure 13. Collapsed crossing obstructing a stream channel.*

their extinction and, thus, alleviate the allegation by NGO of the destruction of rainforests and wildlife habitat.

## IMPLICATION OF ENSO EVENT ON CRUDE PALM OIL PRICE

Anticipation of the occurrence of a strong ENSO event partly influences the movement of CPO price as such an event is the most important factor in determining FFB yield and CPO production pattern. Thus, any significant changes in the amount of rainfall will be reflected in the supply pattern of palm oil, and this will consequently influence CPO price movements.

The strong occurrences of *El Niño* and *La Niña* influence the price movements. This can be seen during the 1997/1998 period when the strong *El Niño* event occurred, pushing CPO price from an average of RM 1350 t to almost RM 2400 t, a surge of 78% within a year (*Figure 14*). *Table 3* shows the results from a linear regression analysis. The results suggest that there was no significant relationship between rainfall and CPO price. However, CPO production does affect the movements in CPO price.

Based on the regression analysis, for every 1% decline in CPO production, CPO price will increase by 0.04% (*Table 3*). This is based on Equation (1):

$$CPOP_i = \alpha + \beta_1 SBO_i - \beta_2 POPROD_i + \beta_3 POEX_i + \beta_4 RAINFALL_i + \varepsilon_i$$

where:

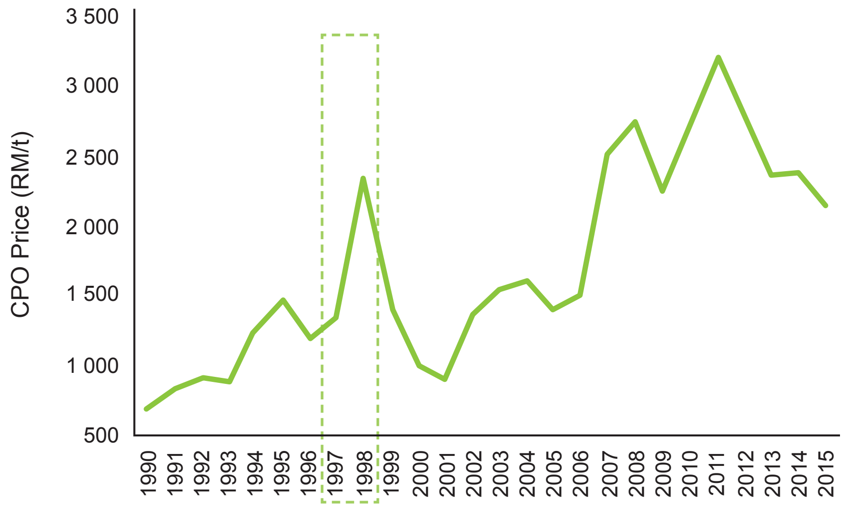
CPOP - crude palm oil price in USD/t

SBO - soyabean oil price in USD/t

POPROD - palm oil production in tonnes

POEX - palm oil export in tonnes

All the data are monthly data from the year 2006 to 2015.




Source: MPOB (2016).

*Figure 14. Average crude palm oil (CPO) price, 1990-2015.*

**TABLE 3. LINEAR REGRESION ANALYSIS OF CRUDE PALM OIL (CPO) PRICE**

| Independent variable | B | SE | t-stat | Prob |
|---|---|---|---|---|
| Constant | -2.0183 | 0.7065 | -2.8569 | 0.0051* |
| Ln soyabean oil price | 0.8322 | 0.0275 | 30.2208 | 0.0000* |
| Ln CPO production | -0.0461 | 0.0161 | -2.8562 | 0.0051* |
| Ln PO export | 0.2700 | 0.0600 | 4.5152 | 0.0000* |
| Ln rainfall | 0.0335 | 0.0217 | 1.5408 | 0.1261 |
| Adjusted $R^2$ | 0.9039 | - | - | - |
| N | 120 | - | - | - |

Note: *Statistical significance at 1%
PO - palm oil.

## CONCLUSION

In conclusion, climate variability does significantly influence the palm oil production pattern in Malaysia. However, the impact arising from adverse weather conditions on crop productivity is subject to the intensity of the El Niño and *La Niña* event. A mild and weak *El Niño* for instance will not give much of an impact to the country. However, a moderate or strong *El Niño* can cause rainfall to be lower in amount than normal, particularly over east Malaysia, hence, affecting the oil palm production pattern. Unlike *La Niña*, the impact of *El Niño* on CPO production is not immediate. Prolonged hot and dry weather affects mostly the key physiological stages relating to inflorescence abortion and sex determination which have a lag period of 9-11 and 22-23 months before harvest, respectively. As a consequence, the effects of a strong *El Niño* can be seen only 9 to 24 months after the event.

In contrast, during *La Niña*, CPO production will normally drop immediately. The drop is mainly attributable to disruptions in harvesting and FFB collection caused by floods, and not to effects on the fruiting stage itself. This impact is short-lived. As the water level subsides, harvesting and collection will resume. Heavy rainfall by itself leaves no negative impact on the oil palm growth stages. However, if the palms are submerged for more than a month, there is a high chance of the palm, particularly a young palm, to die. Therefore, it is important for planters to have a good water management system to reduce the impact of climate variability on the oil palm industry. Any supply shock arising from these events will have an impact on CPO price, consequently affecting Malaysia's Gross Domestic Product (GDP) as palm oil is one of the major contributors to the government revenue.

## REFERENCES

AUSTRALIAN BUREAU OF METEOROLOGY. ENSO Wrap up. http://www.bom.gov.au/climate/enso/.

CORLEY, R and TINKER, P (2003). *The Oil Palm*. Oxford: Blackwell Science Ltd.

HARUN, M H; MOHAMMAD, A T; NOOR, M R; DIN, A K; LATIFF, J; SANI, A R and ABDULLAH, R (2010). Impact of *El-Nino* occurence on oil palm yield in Malaysia. *The Planter, 86 (1017)*: 837-852.

MALAYSIA EXTERNAL TRADE DEVELOPMENT CORPORATION (2016). Top 10 major export products, 2015. Kuala Lumpur, Malaysia.

MPOB (2016). *Malaysian Oil Palm Statistics 2015*. 35$^{th}$ edn. MPOB, Bangi.

NATIONAL OCEANIC ATMOSPHERIC ADMINISTRATION OF THE UNITED STATES. *El Niño & La Niña* (*El Niño*-Southern Oscillation).

pacificclimatechangescience.org. (n.d.). Understanding climate variability and change.

SHANMUGANATHAN, S and NARAYANAN, A (2012). Modelling the climate change effects on Malaysia's oil palm yield. Modelling the climate change effects on MIn E-Learning, E-Management and E-Services (IS3e). 2012 IEEE Symposium on IEEE. p. 1-6.

STATE ENVIRONMENTAL CONSERVATION DEPARTMENT (ECD), SABAH, MALAYSIA (2002). *Environmental Impact Assessment (EIA) Guidelines on Oil Palm Plantation Development.* Sabah, Malaysia.

NORMAN, K; TARMIZI, A and KUSHAIRI, A (2014). Oil palm cultivation: enhancing sustainable palm oil production. Palm Oil Familiarisation Programme. MPOB, Bangi.

VERHEYE, W (2010). *Growth and Production of Oil Palm*. Oxford, UK.