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Climate change and Paddy Yield in Malaysia: A short communication

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Abstract

Rice is the most important staple of the Malaysian and paddy is the second most produced crop of the nation. Traditionally, population rise generates higher demand for milled rice in Malaysia. However, in the past 30 years, milled rice production in Malaysia has been falling short of the demand, prompting import of rice from other nations. The impact of climate change on paddy yield is foreseen to widen the gap of local supply and demand. Increasing temperature has been shown to be more damaging to paddy yield than rainfall variation. 1% increase in temperature could result in 3.44% drop in current paddy yield while a 1% increase in rainfall could cut current paddy yield by 0.12%. With rising temperature, increasing CO_2 concentration is not predicted to enhance paddy yield though the photosynthetic rate of paddy depends on atmospheric CO_2 concentration. This implies a more deleterious effect of temperature on paddy yield. Draught ensuing rainfall variability can also severely reduce paddy yield. Adaptation of paddy farmers to the impacts of climate change is crucial and this can be achieved with technology advancement in agricultural practices as well as research and development of new paddy breeds.

Keywords: Climate change; Malaysia; Paddy; Rice; Yield

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Introduction

Paddy is the second most produced crop in Malaysia with 2.74 million tonnes produced in year 2018. Its production tonnage, though ranked second, was significantly lower than the fresh fruit bunches of oil palm at 86 million tonnes [1]. Paddy is by far the most consumed staple in Malaysia. In 2016, per capita rice consumption of the Malaysian stood at 80kg equivalent to about 26% of the total daily caloric intake. This was translated to an average of RM44/month per household [2]. As of 2018, the milled rice domestic consumption was reported at 2.75 million tonnes [3]. The paddy production and milled rice consumption figures show an obvious deficit. Milled rice produced from the harvested paddy in the same year was estimated at 1.82 million tonnes, thus aggravating the rice deficit [3]. This deficit prompted the import of rice to Malaysia from countries such as Thailand, Vietnam, Pakistan and Cambodia. In 2015, the rice import totalled

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0.96 million tonne which was equivalent to RM1,740.3 million [4]. In fact, Malaysia has been a net importer of rice for about three decades [5]. Recently, the Malaysian government has endeavoured to reduce dependency of imported rice by increasing local rice production to 75% from the current 70% but this is faced with the challenges due to climate change [2]. In addition to factors such as weak paddy farm extension programs and poor farm management practices, varying climate pattern characterized by irregular rainfall and increasing tropical cyclones also poses threat to rice production, hence national food security [2]. With only about 7% of the global milled rice traded, the need to increase the rice stock of Malaysia seems impetus [4]. This article probes the impacts of climate change on the paddy yield of Malaysia to motivate efforts in adapting to the impacts, hence contributing to the national food security and the income of rice farmers.

Rice Production in Malaysia

The milled rice production tonnage in Malaysia has been rising over the years (Figure 1). The percent growth calculated as the difference in the production tonnage of a particular year with that of the previous year divided by the production tonnage of the previous year, expressed in percent, has been fluctuating [3]. The extent of fluctuation, however, appears to narrow since 2007 signalling a more stable yet static production compared to the previous years (Figure 2). Rice production has been closely tied to weather conditions. Variations in the rainfall and temperature have generally had an adverse impact on the Malaysian agriculture [6]. Nonetheless, domestic demand is still the most important driving force behind rice production [7]. With the Malaysian population increasing year by year (Figure 3), the milled rice production demonstrates a similar trend (Figure 1). A slower rate of population growth after 2010 (Figure 4) is also captured by a more static growth in the milled rice production (Figure 2). Other factors such as the preference for specialty rice particularly jasmine and basmati rice [4], as well as climate, also affect milled rice production, producing trend in milled rice production which does not mirror that of the population growth.

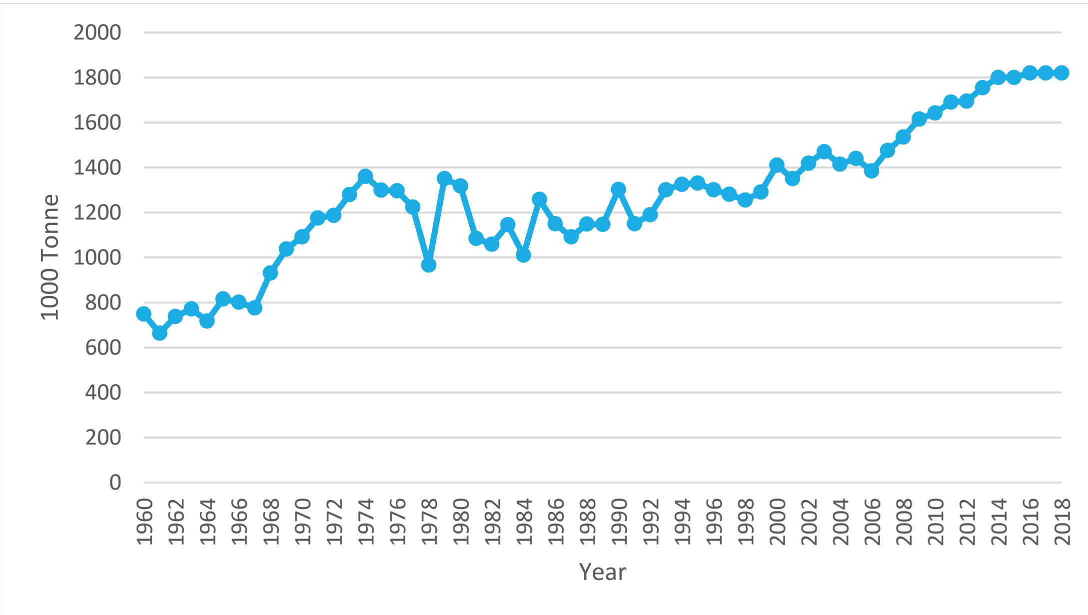

Figure 1: Production of Milled Rice in Malaysia [3].

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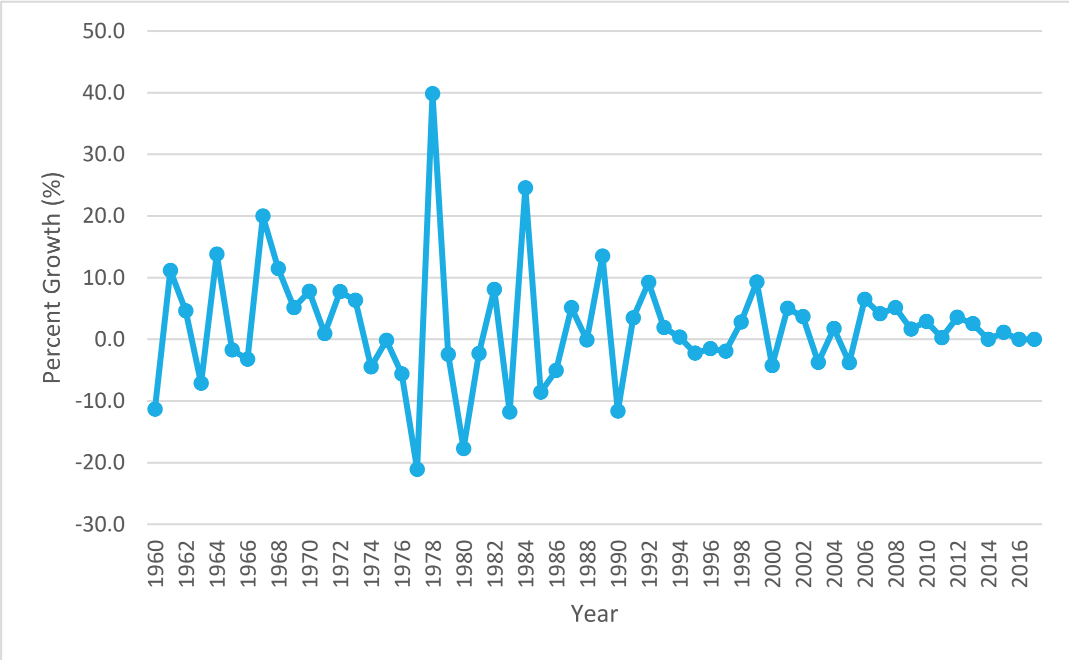

Figure 2: Percent Growth of Milled Rice Production in Malaysia [3].

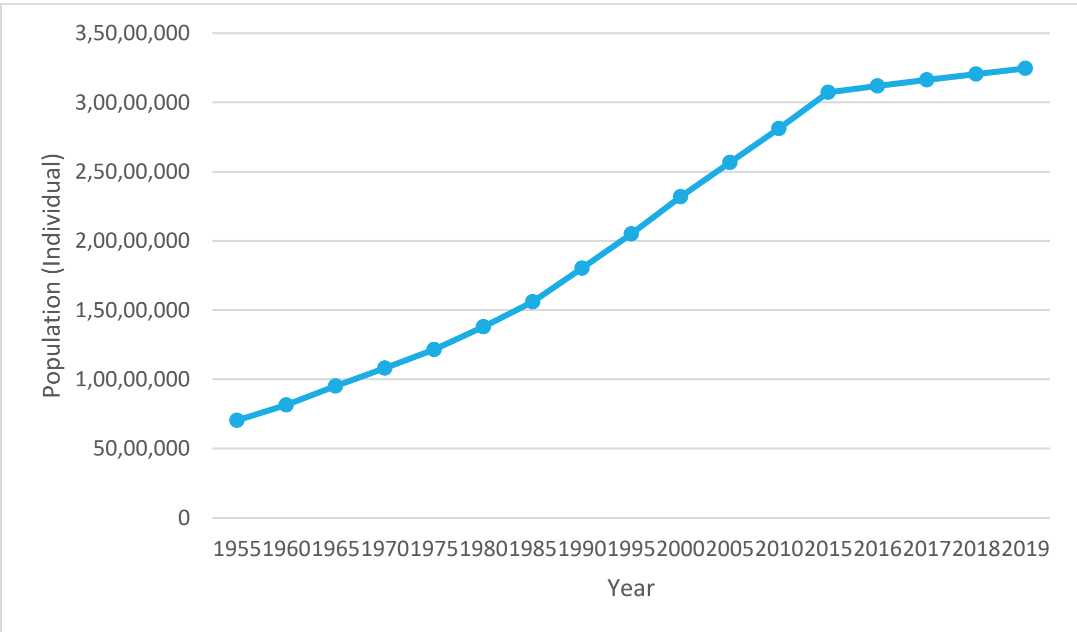

Figure 3: Population of Malaysia [8].

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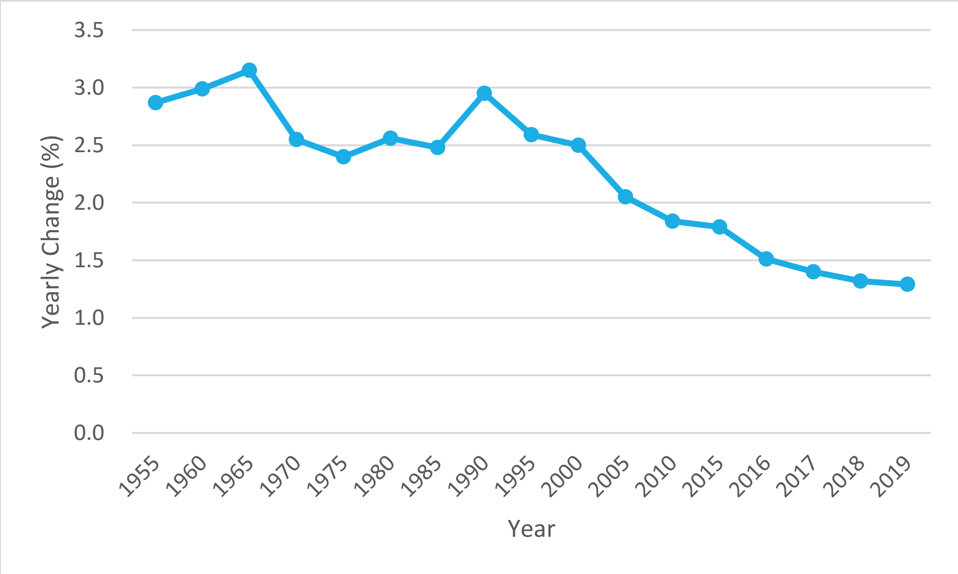

Figure 4: Yearly Change of the Malaysian Population [8].

The Effects of Climate Change on Paddy Yield

Food security has been on the national agenda as reflected in the Third National Agriculture Policy (1998-2010) and the National Argo-Food Policy (2011-2020) [9]. Climate change is perceived as an increasing threat to food security [9]. Extreme weather events such as floods, droughts and tropical cyclones have resulted in agricultural and fishery losses. Floods are one of the most common threat to paddy cultivation. Monsoon floods in Malaysia have constantly been reported to bring damages to paddy fields [10]. Heightening climate change has made these weather events more unpredictable, resulting in agricultural losses beyond the rainy monsoon season commonly lasting from October till March annually [11]. Paddy farming is vulnerable to rainfall variation which results in floods and droughts. As such, studies have been conducted to examine how paddy farming is impacted by the future climatic variations in Malaysia. Various climate simulations showed that Malaysia would warm between 1ºC and 4.2ºC by the end of the 21st century depending on the greenhouse gas emission scenarios [12]. Some models showed warming of the peninsular Malaysia by 2.3ºC to 3.7ºC and warming of the Malaysian Borneo by 2.4ºC to 3.7ºC towards the end of this century [13]. Rainfall models varied but pointed to more irregular rainfalls and higher probability of extreme rainfall events [12,13]. Alam et al. predicted that a 1% increase in temperature could result in 3.44% drop in current paddy yield while a 1% increase in rainfall could cut current paddy yield by 0.12%. They also highlighted that the gap between potential and actual paddy yields in Malaysia would continue to widen [6]. While excessive rain contributes to paddy loss, variable rainfall in the future also implies less predictable draught and less rainfall to certain regions such as Selangor which is extremely harmful to paddy production [6]. 15% reduction in season rainfall could cut paddy yield by as much as 80%. Coupled with increasing heat episodes, it is foreseen that the population of rice pest will also increase [2].

Increasing atmospheric CO_2 has been shown to increase the rate of photosynthesis, hence the growth of C3 plant and paddy is a type of C3 plant whose photosynthetic rate depends on the concentration of CO_2 in the air [14]. In view of the potential positive effect of atmospheric CO_2 concentration on paddy growth and yield, Vahedi et al. modelled the variation of paddy

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yield based on temperature and CO_2 increase, and found that CO_2 increase aggravated paddy loss. A temperature increase of 2ºC at current CO_2 level of 383ppm would cut paddy yield by 0.36 tonne/ha while an increase of CO_2 level to 574ppm at the same temperature rise would cut paddy yield by 0.69 tonne/ha [15]. These results showed that increasing temperature is deleterious to the growth enhancing effect of CO_2. They are consistent with the earlier findings of Baker and Allen that temperature increase reversed lower evapotranspiration and higher water-use efficiency due to CO_2 enrichment [14]. Ricardian model has also been employed to forecast how climate change impacts net revenue of paddy at granary level. Modelling showed temperature rise having a significantly greater impact on net revenue per hectare than rainfall, in line with Alam et al. [6], with a decline of RM442.23 for a 1ºC rise compared to -RM0.01 for a 1% rainfall drop [16]. An earlier study by the Ministry of Science, Technology and the Environment in 2001 showed an increase or decrease of rainfall and temperature beyond 0.4% would adversely impact paddy yield and the impact worsens with increasing variation of rainfall and temperature. This is again parallel to the projected reduction of paddy yield with temperature and rainfall variation above [17].

Conclusion

With climate change projected to adversely affect paddy yield, much research has focused on adaptation of farmers to climate change. Such research revolves around two facets, i.e. how farmers can manage the impacts of climate change on their incomes as well as how paddy yield can be sustained and improved to ensure food security [12]. A study showed local irrigation scheme effective in countering water shortage during the dry monsoon season, thus minimizing the impacts of rainfall variation on paddy yield [18]. This indicates that facilitation of farmers' adaptation can be linked to technology as well as research and development of temperature-tolerant high-yielding paddy breeds. The farmers could then be trained to adopt the new paddy-farming technology and paddy breeds. While mitigating climate change is the ultimate aim, adaptation of the farmers to climate change is deemed crucial before the ultimate aim can be achieved.

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