



UNIVERSITI PUTRA MALAYSIA

***ECONOMIC IMPACT OF CLIMATE CHANGE ON
MALAYSIAN RICE PRODUCTION***

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**ECONOMIC IMPACT OF CLIMATE CHANGE ON
MALAYSIAN RICE PRODUCTION**

By

SEYEDEH NEGIN VAGHEFI

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
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Doctor of Philosophy**

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DEDICATION

To my lovely husband, Milad who has supported me throughout this study



Abstract of thesis presented to the Senate of Universiti Putra Malaysia
in fulfilment of the requirement for the degree of Doctor of Philosophy

**ECONOMIC IMPACT OF CLIMATE CHANGE ON
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July 2013

Chair: Professor Mad Nasir Shamsudin, PhD

Faculty: Environmental Studies

Climate change poses challenges for all sectors of an economy, particularly those dependent on natural resources such as agriculture. Studies have shown that overall agricultural productivity in low latitudes are likely to decline with the effect of climate change. This has implications for world food security, as most developing countries, including Malaysia, are located in lower latitude regions. This will subsequently affect farm income, self-sufficiency level and food security. Rice production in Malaysia, as in other parts of the world, is extremely vulnerable to weather changes and extreme conditions such as drought and flooding. Such situations forced Malaysia to start and maintain a protectionist regime with respect to its rice industry to better ensure food security for the country.

This study attempts to investigate the economic impact of climate change on the Malaysian rice industry, a strategic crop that largely determines the Malaysian food

security. The study involves estimating the potential impact of temperature and rainfall changes on rice yields in the major rice granary areas until 2030, and policy simulation under the present and alternative policy scenarios on the rice industry. This study employed a Crop Simulation Model (DSSAT) to predict the rice production in the eight granary areas until 2030, based on projected weather data. The DSSAT model can simulate growth, development, and yield of a crop growing on a uniform area of land under recommended or simulated management. It needs the minimum data sets including weather data, soil data, and crop management data.

The projected climate change over Peninsular Malaysia showed an increasing trend for maximum, minimum temperatures and changes in rainfall pattern. Increase in temperature and variations in rainfall pattern over the growing period were found to affect the rice yield. Results show that during the main growing season, a yearly increase in temperature by 0.05°C and rainfall by 0.11mm can be expected to reduce the rice yield by 12% until the year 2030. During the off season, a yearly increase of maximum and minimum temperatures by 0.15°C and 0.08°C , respectively, and a reduction in rainfall by 0.19mm would reduce the rice yield by 31.3% over the next 18 years. These results indicated that rice yield would be more negatively affected by the climate change during off season rather than main season.

The system dynamics simulation model then used to assess the effect of predicted yield on self sufficiency level and farmers' gross income of the country until 2013.

It is an approach for analysing and solving complex problems, and focuses mostly on policy analysis and design. Based on the system dynamics' results, the reduction in rice yield was expected to reduce farmers' gross income and the rice self sufficiency level of the country.

The study suggested three different policy scenarios to overcome these adverse effects. Under Scenario 1, a doubling of the government's fertilizer subsidy from the year 2013 to 2030 was able to increase the rice yield, SSL, and farmers' gross income about 3–4%, 0.3–5.6%, and 8.3–12.7%, respectively. Based on Scenario 2, if the government increases the price support by 10% during the 2013 to 2030 time period, the farmers' income will also increase by 1.7% per year. Under Scenario 3, Malaysia may be able to sustain the 70% SSL target until 2020, if the government open about 51,565 ha of new land area for rice fields. Malaysia also can maintain this level of self sufficiency until 2030, if the area planted increase to 154,000 ha. The overall policy implication is that the Malaysian rice industry cannot be sustained if government takes no action to change its current policies.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**KESAN EKONOMI PERUBAHAN IKLIM TERHADAP
PENGELUARAN BERAS MALAYSIA**

Oleh

SEYEDEH NEGIN VAGHEFI

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Cabaran perubahan iklim memberi kesan terhadap semua sektor ekonomi, terutamanya kepada yang bergantung kepada sumber asli seperti pertanian. Kajian menunjukkan bahawa produktiviti pertanian di latitud rendah berkemungkinan akan merosot akibat perubahan iklim. Hal ini memberi implikasi terhadap sekuriti makanan dunia kerana kebanyakan negara-negara membangun termasuk Malaysia terletak di kawasan latitud rendah. Ini akan memberi kesan terhadap pendapatan ladang, tahap sara diri dan sekuriti makanan. Pengeluaran beras di Malaysia, seperti di bahagian lain di dunia, adalah sangat terdedah kepada perubahan cuaca dan keadaan yang ekstrem seperti kemarau dan banjir. Situasi sedemikian memaksa Malaysia untuk memulakan dan mengekalkan rejim perlindungan untuk industri beras bagi memastikan keselamatan makanan untuk Negara.

Kajian ini bertujuan untuk meneliti kesan ekonomi terhadap perubahan iklim ke atas pengeluaran padi dan beras yang merupakan tanaman strategik yang menentukan tahap sekuriti makanan Malaysia. Kajian ini menganggarkan potensi kesan perubahan suhu dan hujan terhadap hasil padi di kawasan jelapang utama padi sehingga tahun 2030. Kajian ini juga melibatkan simulasi dasar keadaan sekarang dan senario dasar alternatif terhadap industri Beras. Kajian ini mengaplikasi Model Simulasi Tanaman (DSSAT) untuk meramalkan masa depan pengeluaran beras di lapan kawasan jelapang padi sehingga 2030 berdasarkan ramalan data cuaca. Model DSSAT boleh mensimulasi pertumbuhan, pembangunan, dan hasil tanaman yang ditanam di kawasan tanah sekata berdasarkan cadangan pengurusan atau pengurusan simulasi. Ia memerlukan set data yang minimum termasuk data cuaca, data tanah, dan data pengurusan tanaman.

Unjuran perubahan iklim di seluruh Semenanjung Malaysia menunjukkan tren yang meningkat terhadap kadar suhu maksimum, kadar hujan minimum dan perubahan dalam corak hujan. Peningkatan dalam suhu dan variasi dalam corak hujan didapati menjejaskan hasil padi. Keputusan menunjukkan bahawa semasa musim menanam, peningkatan suhu tahunan sebanyak 0.05°C dan hujan sebanyak 0.11mm boleh dijangkakan dimana ia mengurangkan hasil padi sebanyak 12% sehingga tahun 2030. Pada luar musim, peningkatan suhu tahunan maksimum dan minimum adalah sebanyak 0.15°C dan 0.08°C , dan pengurangan hujan sebanyak 0.19mm akan mengurangkan hasil padi sebanyak 31.3% dalam tempoh 18 tahun yang akan

datang. Keputusan ini menunjukkan bahawa kesan perubahan iklim adalah lebih signifikan semasa musim luar dibandingkan dengan musim utama.

Berdasarkan Model Simulasi Sistem Dinamik, penyusutan hasil padi memberi kesan negatif terhadap tahap sara diri, pendapatan petani dan sekuriti makanan. Ia merupakan satu pendekatan untuk menganalisis dan menyelesaikan masalah kompleks, dimana fokus diberikan secara khususnya kepada analisis dasar dan reka bentuk. Implikasi dasar daripada kajian ini adalah sekiranya kerajaan meningkatkan subsidi dan insentif kepada petani, pengeluaran beras negara akan dapat ditingkatkan.

Kajian ini mencadangkan tiga senario dasar yang berbeza untuk mengatasi kesan-kesan buruk. Di bawah Senario 1, penggandaan subsidi baja kerajaan dari tahun 2013 hingga 2030 dapat meningkatkan hasil padi, SSL, dan pendapatan kasar petani kira-kira 3-4%, 0.3-5.6%, dan 8.3-12.7%. Berdasarkan Senario 2, jika kerajaan meningkatkan sokongan harga sebanyak 10% dalam tempoh masa 2013 hingga 2030, pendapatan petani juga akan meningkat sebanyak 1.7% setahun. Di bawah Senario 3, Malaysia mungkin dapat mengekalkan sasaran 70% SSL sehingga tahun 2020, jika kerajaan membuka kira-kira 51,565 hektar kawasan tanah baru untuk sawah padi. Malaysia juga boleh mengekalkan tahap sara diri sehingga 2030, jika kawasan tanaman meningkat kepada 154,000 hektar. Keseluruhan implikasi dasar menunjukkan bahawa industri beras Malaysia tidak boleh dikekalkan jika kerajaan tidak mengambil tindakan untuk mengubah dasar-dasar semasa.

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I certify that an Examination Committee has met on 05 July 2013 to conduct the final examination of Seyedeh Negin Vaghefi on her thesis entitled "Economic Impact of Climate Change on Malaysian Rice Production" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the Doctor of Philosophy.

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I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

SEYEDEH NEGIN VAGHEFI

Date: 5 July 2013

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