UNIVERSITI PUTRA MALAYSIA

PRODUCTION BEHAVIOR AND EFFICIENCY ANALYSIS OF PADDY FARM IN GRANARY AREAS OF PENINSULAR MALAYSIA

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FP 2015 47

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By

LIRA MAILENA

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

December 2015

Especially dedicated to my beloved husband, Achmad Husna, my lovely parents and my lovely kids Aini Nurrohmah Husna, Raihan Fauzi Husna and Humaira Salsabila Husna.May Allah S.W.T bless you always. Ameen

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

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Chairman: Professor. Datuk. Mad Nasir Shamsudin, PhD
Faculty: Agriculture

Increasing paddy production through improvement on the paddy yield is the substantial effort to achieve the self-sufficiency level at 70 percent of local consumption by 2020 and Ministry of Agriculture and Agro-based Industry (MoA) of Malaysia set the national paddy yield target at 10 t/ha. Emphasis is focused in eight granary areas of Peninsular Malaysia that are potentially able to achieve the paddy yield target since these granary areas are designated as the main producing center of paddy in Peninsular Malaysian, whereas government supports in production are focused in these areas. Despite various government supports, paddy production is hampered by the lower paddy yield compared to the yield target. In 2008-2013, the average national paddy yield was roughly 3.9t/ha and the average paddy yield in the granary areas varied between 2.96 t/ha and 5.74 t/ha. In same period, national paddy yield grew at 1.30 percent only and the paddy yield growth in the granaries was not more than 10 percent over year. Since at a current technology, the yield is normally associated with the input use, the low paddy yield and slow growth of paddy yield was potentially caused by the technical inefficiency in the input use.

The incentive to use more input is constrained by the input prices when policy instruments and subsidies for domestic industry including paddy farms should be reduced as expected in the trade liberalization. In this condition, how the farmer's response to the change of input prices principally inflames the incentive to use input in paddy production. Besides, Guaranteed Minimum Price (GMP) and price support program that reflected in the paddy price, are other important support to encourage farmers to increase the paddy production. However, to the best of our knowledge, not many estimates on the response of paddy supply to the paddy prices and the response of input demand to the input prices have been reported while the production efficiency depends on this behavior. Therefore, this study generally aims to analyze the production behavior and the efficiency of paddy farms in granary areas of Peninsular Malaysia. The specific objectives are (1) to estimate the production behavior of paddy farm in terms of input demand and output supply elasticity, production elasticity and return to scale, (2) to measure the technical and scale efficiency of paddy farm based on the parametric

(stochastic frontier analysis) and nonparametric approaches (DEA and bootstrapped DEA) in order to depict more holistic feature of paddy farms efficiency in Peninsular Malaysia, and (3) to determine factors affecting the technical efficiency of paddy farm based on farmer's characteristics.

Duality theory with restricted transcendental profit function was utilized as it was able to depict the behaviour of input demand and output supply simultaneously. Stochastic Frontier Analysis and Data Envelopment Analysis improved by bootstrapping method were used to measure the level of technical and scale efficiency. In addition, this study used the Tobit model whereas the technical efficiency scores were regressed upon the farmer's characteristics that could explain variation on the technical efficiency.

The findings of this study show that output supply of paddy in most of granary areas (MADA, IADA Pulau Pinang, KADA, IADA KETARA, IADA Kerian Sungai Manik and IADA Barat Laut Selangor) was responsive to the changes of paddy prices and indicated that price support program was effectively encouraging farmers to increase the production. Responsiveness of input demand to its price varied across granary areas and the input demands mostly, were not elastic to the changes of its price.

Regarding the result of technical efficiency measurement, paddy farms were not fully technically efficient since the average technical efficiency scores were lower than one. Based on parametric (SFA) and nonparametric (DEA) approaches, the average efficiency scores ranged between 0.42 and 0.69 and suggested that paddy production could be increased by 58 percent of the current production. In addition, out of eight granary areas, paddy farms in IADA Barat Laut Selangor were the most technically efficient farms. However, after correcting the bias in the bootstrapping technique, bias corrected technical efficiency scores were lower than DEA and SFA efficiency scores and paddy farms in those areas should increase the production by 69.5 percent of the current output to achieve the potential production. Hence, bootstrapping technique proved that technical efficiency scores from both approaches were overestimated.

In addition, the average of scale efficiency scores were higher than technical efficiency scores and it suggested that inefficiencies were mostly due to inefficient technical practices in the input use rather than the scale of production. Therefore, production increase by improving technical efficiency of paddy farms could be gained by the optimal utilization of production inputs mainly the seed and fertilizer use. In this context, an extension program with regards to the optimal level of seed and fertilizer on the best farm practices should be emphasized. Besides, experienced farmers in IADA Pulau Pinang, Kerian Sungai Manik and Seberang Perak could be the benchmark for other farmers in this area and it would be helpful for setting targets and finding weaknesses of current practices. Courses and trainings could be emphasized for farmers in KADA and IADA Kerian Sungai Manik as this eventswere helpful to share the knowledge and information on the best farm practices.

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

TINGKAH LAKU PENGELUARAN DAN ANALISIS KECEKAPAN FARM PADI PADA JELAPANG PADI SEMENANJUNG MALAYSIA

Oleh

LIRA MAILENA

Disember 2015

Pengerusi : Professor. Datuk. Mad Nasir Shamsudin, PhD
Fakulti: Pertanian

Peningkatan pengeluaran padi melalui penambahbaikan hasil padi adalah usaha besar untuk mencapai tahap sara diri 70 peratus daripada penggunaan tempatan menjelang tahun 2020 dan Kementerian Pertanian dan Industri Asas Tani Malaysia menetapkan sasaran hasil padi negara pada 10 tan/ha. Penekanan tertumpu pada kawasan jelapang padi di Semenanjung Malaysia yang berpotensi mencapai sasaran hasil padi kerana kawasan jelapang padi ini ditetapkan sebagai pusat pengeluar utama padi di Semenanjung Malaysia, manakala sokongan kerajaan dalam pengeluaran adalah tertumpu di kawasan ini.Walaupun pelbagai sokongan daripada kerajaan, pengeluaran padi terjejas disebabkan oleh hasil padi yang lebih rendah berbanding sasaran hasil padi. Pada 2008-2013, purata hasil padi negara adalah kira-kira 3.9 tan/ha dan purata hasil padi bagi kawasan jelapang padi di antara 2.96 tan / ha dan 5.74 tan/ha. Dalam tempoh yang sama, hasil padi negara meningkat pada 1.30 peratus sahaja dan pertumbuhan hasil padi di jelapang adalah tidak lebih daripada 10 peratus berbanding tahun. Memandangkan pada tingkat teknologi semasa, hasil biasanya dikaitkan dengan penggunaan input, hasil padi yang rendah dan pertumbuhan hasil padi yang perlahan berpotensi disebabkan oleh ketidakcekapan teknikal dalam penggunaan input.

Insentif untuk penggunaan input yang lebih banyak juga dikekang oleh harga input apabila instrumen dasar dan subsidi untuk industri domestik termasuk sawah padi perlu dikurangkan seperti yang dijangka dalam liberalisasi perdagangan. Dalam keadaan ini, bagaimana tindak balas petani terhadap perubahanharga input secara dasarnya mempengaruhi insentif untuk menggunakan input dalam pengeluaran padi. Selain itu, Harga Minimum Terjamin (GMP) dan program sokongan harga yang dicerminkan dalam harga padi, adalah antara sokongan penting untuk menggalakkan petani meningkatkan pengeluaran padi. Tetapi, sepanjang pengetahuan kami, tidak banyak jangkaan ke atas tindak balas penawaran padi berkaitan dengan harga padi dan tindak balas permintaan input berkaitan dengan harga input yang telah dilaporkan, manakala kecekapan teknikal adalah bergantung kepada aspek ini. Oleh kerana itu, kajian ini bertujuan untuk menganalisis tingkah laku pengeluaran dan kecekapan sawah padi di kawasan jelapang padi Semenanjung Malaysia. Objektif khusus adalah (1) untuk menganggarkan tingkah laku pengeluaran sawah padi dari segi keanjalan permintaan input dan penawaran output,

keanjalan pengeluaran dan pulangan kepada skala, (2) untuk mengukur kecekapan teknikal dan skala sawah padi yang berasaskan pendekatan parametrik (*SFA*) dan bukan parametrik (*DEA* dan *bootstrapped DEA*) untuk menggambarkan kecekapan sawah padi secara lebih holistik di Semenanjung Malaysia, dan (3) untuk menentukan faktor-faktor yang memberi kesan kepada kecekapan sawah padi berdasarkan ciri-ciri petani.

Teori kedualan dengan fungsi keuntungan transcendental terhad digunakan kerana ia dapat menggambarkan tingkah laku permintaan input dan penawaran output secara serentak. Stochastic Frontier Analisis (*SFA*) dan Data Envelopment Analisis (*DEA*) yang telah ditambah baik dengan kaedah bootstrapping digunakan untuk mengukur tahap kecekapan teknikal dan kecekapan skala. Di sampingitu, kajian ini menggunakan model Tobit yang menerangkan faktor-faktor yang mempengaruhi kecekapan teknikal.

Hasil kajian ini menunjukkan bahawa bekalan pengeluaran padi di kebanyakan kawasan jelapang padi (MADA, IADA Pulau Pinang, KADA, IADA KETARA, IADA Kerian Sungai Manik dan IADA Barat Laut Selangor) adalah responsive kepada perubahan harga padi dan menunjukkan program sokongan harga berkesan untuk menggalakkan peningkatan pengeluaran padi. Respon permintaan input kepada harga input berbeza di keseluruhan kawasan jelapang padi dan penggunaan input kebanyakannya tidak anjal kepada perubahan harganya.

Mengenai keputusan pengukuran kecekapan, sawah padi tidak sepenuhnya cekap dari segi teknikal memandangkan purata tahap kecekapan adalah lebih rendah daripada satu. Berdasarkan pendekatan parametric dan bukan parametrik, purata tahap kecekapan teknikal adalah di antara 0.42 dan 0.69 dan mencadangkan bahawa pengeluaran padi boleh ditingkatkan sebanyak 58 peratus daripada pengeluaran semasa. Daripada lapan kawasan jelapang padi, sawah padi di IADA Barat Laut Selangor adalah sawah padi yang paling cekap secara teknikal. Selanjutnya, selepas pembetulan bias dalam kaedah bootstrapping, tahap kecekapan teknikal adalah lebih rendah daripada tahap kecekapan DEA dan SFA dan sawah padi di kawasan-kawasan itu perlu meningkatkan pengeluaran sebanyak 69.5 peratus daripada pengeluaran semasa untuk mencapai potensi keluaran padi. Oleh itu, kaedah bootstrapping menggambarkan bahawa hasil pengukuran kecekapan sawah padi dengan pendekatan parametric dan bukan parametric ialah terlalu tinggi.

Disamping itu, purata skor kecekapan skala lebih tinggi daripada skor kecekapan teknikal dan ia dicadangkan bahawa ketidakcekapan kebanyakannya disebabkan oleh amalan teknikal yang tidak cekap dan bukannya skala pengeluaran. Oleh itu, peningkatan pengeluaran dengan meningkatkan kecekapan teknikal sawah padi boleh diperolehi dengan penggunaan input pengeluaran yang optimum utamanya benih dan baja. Dalam konteks ini, program pendidikan untuk petani berkaitan dengan penggunaan input benih dan baja yang optimum pada amalan sawah terbaik perlu ditekankan. Di samping itu, petani yang lebih berpengalaman dalam persawahan padi di IADA Pulau Pinang, Kerian Sungai Manik dan Seberang Perak boleh menjadi penanda aras bagi petani lain di kawasan ini yang mana ia akan membantu untuk menetapkan sasaran dan mencari kelemahan amalan persawahan padi semasa. Kursus dan latihan boleh lebih difokuskan bagi petani dalam jelapang padi KADA dan IADA Kerian Sungai Manik kerana program tersebut menjadi sangat berguna untuk berkongsi pengetahuan dan maklumat tentang amalan sawah yang baik.

ACKNOWLEDGEMENT

Alhamdulillahirabbil'alamiin. Thanks to Allah s.w.t for giving me all the courage and competence to complete this level.

I would like to express my deep sense of gratitude to my supervisor, Professor. Datuk. Dr. Mad Nasir Shamsudin, who always supported and provided me with guidance in conducting the research and being fully understanding during the process and completion of this study. I wish to thank all my committee members; Prof. Dr. ZainalAbidin Mohamed, Assoc. Prof. Dr. Ismail Latif and Assoc. Prof. Dr. Alias Radam. I sincerely appreciate them for spending innumerable hours in reading the draft and suggesting improvement on my thesis.

I am grateful to Indonesian Agency for Agricultural Research and Development for sponsoring the whole period of my study at Universiti Putra Malaysia. Sincere thanks are also extended to Universiti Putra Malaysia for providing the portion of the required research fund. Special thanks are extended to the staffs of Agricultural Development Authority for their friendly cooperation during the process of survey. I owe the farmers very much, who have taken all the troubles of responding to the questionnaire and provided the raw materials for this research.

Special thanks are extended to my beloved husband, Achmad Husna for his great support at all times, the worst and the best, he stands by me. I appreaciate the concern of my daughter Aini Nurrohmah Husna for her understanding from the beginning of my study until completion. I also appreciate the concern of my son, Raihan Fauzi Husna for sacrificing the needed attention of his mother. Finally, my deep appreciation is to my beloved parents and sibling for their invaluable encouragement and support.

I certify that a Thesis Examination Committee has met on 22nd December 2015 to conduct the final examination of Lira Mailena on her thesis entitled "Production Behavior and Efficiency Analysis of Paddy Farm in Granary Areas of Peninsular Malaysia" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U. (A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows.

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FAO	Food and Agricultural Organization
DEA	Data Envelopment Analysis
SSL	Self Sufficiency Level
MoA	Ministry of Agriculture
SFA	Stochastic Frontier Analysis
TE	Technical Efficiency
VRS	Variable Return to Scale
CRS	Constant Return to Scale
IADA	Integrated Agricultural Development Authority
RM	Ringgit Malaysia
SAS	Statistical Analysis Software
MLE	Maximum Likelihood
CD	Cobb Douglas
Translog	Transcendental Logarithm

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Rice is a highly sensitive product in many parts of Asia due to its function as the principal staple food that provides the largest single source of calories for a significant majority of Asian population and a mainstay for the farming population. Therefore, despite the general drift towards market liberalization, rice has remained among the most protected agricultural commodities in Asia.

During the green revolution era, rice production in Asia increased by more than 100 percent, outstripping the population growth. This increased the availability of rice and decreased the price and even several countries like Cambodia, China, India, Indonesia and Philippines achieved self-sufficiency in that period. Nevertheless, since the mid 1980s, the rice yield tends to be stagnant at 4.3 t/ha due to the environmental degradation and over-exploitation of soil and water resources (FAO stats, 2013). It leadsto the decreasing of rice production over time and many countries even started to depend on imported rice.

However, the unprecedented food crisis in the late 2007 and early 2008 and the rice price spike in the same period due to trade restriction by Vietnam and India as two major rice exporting countries and a declining value of US dollar has awoken many countries to be reluctant to depend on imported rice. Many countries realized that relying on the market is a risky strategy because of volatility in food prices and possible interruption in supplies. Therefore, that crisis has compelled the entire world to attach high priority to food security through self-sufficiency which focuses on local production to meet the rice consumption rather than import, including in Asia (Timmer, 2010).

As one of the countries in Asia, Malaysia considers rice as a strategic crop of the country as well and hence it is listed as the most important food security crop. Since 1981 until 2013, this country produced 1.36million tons of rice annually with a near stagnant trend at 1.15 percent per year. Rice production achieved the noticeable increase in 2007, 2009 and 2012 with growth rate at 8.79 percent, 6.84 percent and 6.87 percent respectively. However, as presented in Table 1.1, the local consumption grew much higher over time than production.

The local consumption achieved an increase of 2.13 percent growth annually or from 1.48 million tons in 1981 to 2.82 million tons in 2013. As a consequence, rice imports registered a considerable increase of 6.3 percent per year from 0.33 million tons in 1981 to 1.10 million tons in 2013, whereas the main suppliers of the imported rice were Thailand and Vietnam followed by Pakistan, Australia and China.

Table 1.1Rice Production, Consumption and Import, Malaysia,1981-2013

Year	Production	Growth Rate	Consumption	Growth Rate	Import	Growth Rate
	(000 ton)	(%)	*(000 ton)*	(%)	*(000 ton)*	(%)
1981-1990	1148	*-0.21*	1484	*0.29*	332	*3.45*
1991-2000	1341	*1.39*	1757	*2.74*	499	*8.87*
2001	1351	*-2.19*	2010	*3.28*	633	*6.21*
2002	1415	*4.71*	2020	*0.49*	480	*-24.17*
2003	1453	*2.69*	2030	*0.49*	500	*4.17*
2004	1467	*0.96*	2050	*0.98*	700	*40.00*
2005	1490	*1.56*	2150	*4.88*	751	*7.28*
2006	1407	*-5.56*	2166	*0.74*	886	*17.97*
2007	1531	*8.79*	2350	*8.49*	799	*-9.82*
2008	1516	*-0.95*	2500	*6.38*	1093	*36.79*
2009	1620	*6.84*	2540	*1.60*	1130	*3.38*
2010	1588	*-1.96*	2690	*5.91*	935	*-17.26*
2011	1660	*4.50*	2710	*0.74*	1031	*10.27*
2012	1774	*6.87*	2750	*1.47*	1006	*-2.42*
2013	1750	*-1.35*	2825	*2.73*	1100	*9.34*
2001-2013	1540	*1.92*	2369	*2.94*	850	*6.29*
1981-2013	1361	*1.15*	1915	*2.13*	586	*6.29*

Source: Agrofood Statistics (2013),Ministry of Agriculture and Agro Based Industry

Practically, the condition of rice production is closely relates to the condition of paddy farms. As shown in Table 1.2., the paddy planted area in 2013 was about 688 thousand hectares. However, since 1981, the planted area for paddy in Malaysia had a fairly constant growth at 0.1 percent per year and was not more than 700 thousand hectares over time. It was in line with the current economic development due to the increasing use of farmland for nonagricultural purposes and expanding the planted area is not an easy approach due to the problem on water scarcity and high cost development.

Furthermore, although the paddy yield increased to 3.81 kg/ha in 2013 from 2.78kg/ha in 1981, there was a slow growth of paddy yield at only 1.07 percent per year.Besides, paddy yield in 2013 even decreased at the growth of -4.03 percent than paddy yield in 2012. Therefore, Malaysia's total paddy production increased every year at the annual growth of 1.04 percent only and this production could not meet the demand of local consumption.

Table 1.2 Paddy Planted Area, Production and Yield, Malaysia, 1981-2013

Year	Planted Area (000 ha)	Growth Rate (%)	Paddy Production *(000 ton)*	Growth Rate (%)	Yield (t/ha)	Growth Rate (%)
1981-1990	*667*	*-0.44*	*1783*	*-0.22*	*2.7*	*0.06*
1991-2000	*686*	*0.49*	*2078*	*1.96*	*3.0*	*1.09*
2001	674	*-1.85*	*2095*	*-2.14*	3.11	*1.50*
2002	679	*0.73*	*2197*	*4.89*	3.24	*4.18*
2003	672	*-0.99*	*2257*	*2.72*	3.36	*3.70*
2004	676	*0.67*	*2291*	*1.52*	3.43	*2.08*
2005	667	*-1.41*	*2314*	*1.00*	3.47	*1.17*
2006	676	*1.39*	*2188*	*-5.48*	3.24	*-6.63*
2007	676	*0.01*	*2376*	*8.60*	3.51	*8.33*
2008	657	*-2.89*	*2353*	*-0.95*	3.58	*1.99*
2009	675	*2.79*	*2511*	*6.72*	3.72	*3.91*
2010	678	*0.44*	*2465*	*-1.84*	3.64	*-2.15*
2011	688	*1.42*	*2576*	*4.51*	3.74	*2.75*
2012	685	*-0.43*	*2599*	*0.89*	3.97	*6.15*
2013	688	*0.50*	*2627*	*1.08*	3.81	*-4.03*
2001-2013	*676*	*0.03*	*2373*	*1.65*	*3.52*	*1.77*
1981-2013	**676**	***-0.08***	**2105**	**1.04**	**3.12**	**1.07**

Source: Agrofood Statistics (2013), Ministry of Agriculture and Agro Based Industry

In order to increase the production of paddy, Malaysian authority has designated eight granary areas as permanent and main paddy producing centres in Peninsular Malaysia. The granary areas covered an area of about 205.54 thousand hectares. Those eight granaries have been reserved solely for paddy cultivation, where new varieties and technologies that support the yield and production always be disseminated. Those granary areas namely Muda Agricultural Development Area (MADA), Kemubu Agricultural Development Area (KADA), Kerian-Sungai Manik Integrated Agriculture Development Area, Barat Laut Selangor Integrated Agriculture Development Area, Seberang Perak Integrated Agriculture Development Area, Penang Integrated Agriculture Development Area, North Terengganu Integrated Agriculture Development (KETARA) and Integrated Agriculture Development KemasinSemerak. In addition those granary areas become the priority areas for paddy production to supply the national needs of rice, government programs, support and interventions are focused in these eight designatedareas.The profile of those granary areas is presented in Table 1.3.

Table 1.3 Description of Paddy Farms in GranaryAreas of PeninsularMalaysia

Granary Area	Year of Establishment	Land Area (ha)		
		Project Area	Other Agriculture	Paddy
MADA	1965	126,155	109,501	96,558
KADA	1968	89,500	64,555	31,464
IADA KerianSg. Manik	1979	66,282	30,560	28,488
IADA Barat Laut Selangor	1979	199,199	82,044	19,701
IADA Seberang Perak	1981	17,307	16,437	8,529
IADA PulauPinang	1983	104,636	67,095	10,138
IADA KETARA	1992	258,736	65,828	5,110
IADA KemasinSemerak	1982	68,350	46,560	5,560
Total		930,165	482,580	205,548

Source : Agrofood Statistics(2011), Ministry of Agriculture and Agro Based Industry

Out of eight granaries, two of the largest paddy areas are in Muda Agricultural Development Area (MADA) and Kemubu Agricultural Development Area (KADA), which covers about 96.55 thousand hectares and 31.46 thousandhectares respectively. MADA is located in the Northern Region of Peninsular Malaysia and designated as the main producing centre of paddy since 1965, while KADA in the East Coast Region of Peninsular Malaysia was founded in 1968.

Further, IADA Barat Laut Selangor and Seberang Perak which located in the Central Region of Peninsular Malaysia have the planted paddy area of 19.70 thousand hectares and 28.48 thousand hectares respectively. Both granaries were established in 1979. Conversely, among the smallest paddy areas are in Terengganu Utara Agricultural Development Area (KETARA) and IADA KemasinSemerak, which covers 5.11 thousandhectares and 5.56 thousandhectares respectively.

Paddy production from granary areas in the period 2009-2013 and its contribution to the national paddy production is presented in Table 1.4. On average, contribution of those granary areas to the national paddy production reached at 46.83 percent with MADA as the main contributor.

In 2013, paddy production from MADA was about 623 thousand tons and contributed about 24.43 percent of the national production. Meanwhile, granary area of KADA as the second contributor supplied 5.55 percent of the national production and produced about 146 thousand tons paddy in the same year. Then, IADA Barat Laut Selangor in the last five years contributed 5.36 percent of national paddy production and produced 138 thousand tons paddy in 2013 followed by IADA Kerian Sungai Manik with the contribution about 4.86 percent.

Table 1.4 Paddy Production in Granary Areas of Peninsular Malaysia, 2009-2013

Granary Area	Production (000 ton)					Average Contribution 2009-2013 (%)
	2009	2010	2011	2012	2013	
MADA	635	593	622	639	623	24.43
KADA	136	131	141	150	146	5.55
IADA Kerian Sungai Manik	122	113	127	126	126	4.86
IADA Barat Laut Selangor	132	137	144	139	138	5.36
IADA Pulau Pinang	70	75	77	76	75	2.89
IADA Seberang Perak	46	46	49	51	50	1.90
IADA KETARA	32	34	37	34	34	1.33
IADA KemasinSemerak	11	13	11	16	14	0.50
Granary Areas	1184	1142	1208	1231	1206	46.83
Non Granary Areas	1327	1323	1368	1368	1421	53.17
Malaysia	2511	2465	2576	2599	2627	

Source : Booklet Crop Statistics, Ministry of Agriculture and Agro Based Industry (2013)

Unfortunately, production from IADA KemasinSemerak which located in East Coast Region was not more than 16 thousand tons paddy over year and hence provided a contribution only 0.5 percent of the national paddy production. Meanwhile, production from IADA Seberang Perak and KETARA supplied 1.90 percent and 1.33 percent of the national production respectively.

Out of eight granaries, IADA Barat Laut Selangor had the highest productivity over year. In 2013, this granary achieved the paddy yield of 7.0 t/ha, followed by IADA KETARA, MADA and IADA Pulau Pinang with the paddy yield of 6.65 t/ha, 6.45 t/ha and 6.40 t/ha respectively. Conversely, productivity of paddy farms in IADA KemasinSemerak was much lower than other granary areas. Since 2008, paddy yield of this granary was lower than 3.5 t/ha and was lower than national paddy yield as well with the average growth at only 0.78 percent per year.

Furthermore, with the purpose of implementing the food security program for rice sector toward achieving self-sufficiency by 2020, Malaysian authority made an effort to encourage farmers in improving the paddy yield through some strategic policies in paddy farms. Therefore, it is a known fact that paddy and the rice industry is a heavily protected and subsidized industry in Malaysia.

Table 1.5 National and Granary Paddy Yield, 2008-2013

Area	Paddy Yield (t/ha)						Average Paddy Yield (t/ha)	Growth (%/year)
	2008	2009	2010	2011	2012	2013		
MADA	4.59	5.05	4.72	4.96	5.09	6.45	5.14	7.59
KADA	3.58	3.75	3.97	4.09	4.16	4.64	4.03	5.38
IADA Kerian Sungai Manik	3.15	3.48	3.29	3.69	3.66	4.42	3.62	7.44
IADA Barat Laut Selangor	4.76	5.44	5.61	5.91	5.69	7.00	5.74	8.43
IADA Pulau Penang	4.77	5.21	5.59	5.73	5.67	7.40	5.73	9.69
IADA Seberang Perak	4.27	4.62	4.37	4.59	4.83	5.86	4.76	6.88
IADA Ketara	4.68	4.98	5.35	5.83	5.33	6.65	5.47	7.81
IADA KemasinSemerak	2.64	2.83	3.35	2.94	3.47	2.52	2.96	0.78
Malaysia	**3.58**	**3.72**	**3.64**	**3.75**	**3.97**	**3.81**	**3.75**	**1.30**

Source : Booklet Crop Statistics, Ministry of Agriculture and Agro Based Industry (2013)

Government support to paddy and rice industry has been mandated under various National Agricultural Policies (NAPs). Principally, there were three primary objectives of different policies on rice adopted by the government through the decades were defined as follows: (a) ensuring food security; (b) raising farms' income and productivity; and (c) ensuring food supply to consumers at reasonable costs. These were interpreted into three types of rice policies, which are fertilizer subsidies, price support and import restriction or quota. Besides, the government also provides investments in building drainage and irrigation facilities.

In the mid-1949s, the government imposed the important support on paddy production namely Guaranteed Minimum Price (GMP). This policy aims to serve as an incentive to production and to raise farm incomes by guaranteeing a floor price for paddy as well as a means to undermine the role of middlemen in paddy production and marketing. Until 1965, GMP was set at RM 248 per ton of clean dry paddy delivered to the mill door which was higher than the world prices for rice in that period. It further increased to RM 264 per ton in 1967 and RM 397-463 per ton in 1980. In 2010, the government has increased the minimum paddy price to RM750 per ton (Ministry of Agriculture and Agro Based Industry, 2013).

Furthermore, the price support program was introduced in 1980 and set at RM 33 per ton of paddy sold to the National Rice Board or private rice millers or wholesalers. However, due to some grievances expressed by the farmers, the government decided to increase the rate to RM 165 per ton in the same year. In 1990, it was further increased to RM247.5

per ton (Abdullah, 2000) and currently the price support is at RM 248.1 per ton (Ministry of Agriculture and Agro Based Industry, 2013).

The government provided various input subsidy schemes as well, which are 240kg/ha/season of mixed fertilizer, 80 kg/ha/season of organic fertilizer and RM200/ha/season subsidy for the pesticide control. In order to stimulate farmers to improve their paddy yield, the government distributes the incentives at the amount of RM 650 for each ton of increase in yield as compared to the previous year(Ministry of Agriculture and Agro Based Industry, 2013).

Besides subsidies, the government also imposed high import duties on rice to protect the domestic industry. Currently, the import duties for rice imports are 20 percent under the Common Effective Preferential Tariff Agreement (CEPT) of AFTA and 40 percent under the Agreement on Agriculture (AoA) of the WTO. However, the actual situation is that there are no tariffs on rice trades as PadiBeras National Berhad (BERNAS), as the sole importer, has an exemption from the import duty (Vengedasalam*et al.*, 2011). Additionally, the government also provided investments in building drainage and irrigation facilities (Ministry of Agriculture and Agro Based Industry, 2013).

1.2 Problem Statement

The fairly constant growth of paddy planted area and significant increase of local consumption for rice suggested the requirement to increase paddy production by improving the paddy yield rather than increasing the planted area. Therefore, in order to achieve the self-sufficiency level of 70 percent by 2020, Ministry of Agriculture and Agro-based Industry (MoA) set the national paddy yield target at 10 t/ha. Emphasis is focused on the granary areas that potentially could achieve the set paddy yield target.

However, the national and granary area paddy yields were much lower than target. In 2008-2013, the average national paddy yield at roughly 3.75t/ha and MADA as the largest granary area of Peninsular Malaysia achieved the paddy yield between 4.59 to 6.45 t/ha. Besides, KADA attained the average paddy yield not more than 4.64 t/ha in the same period.

Although IADA Barat Laut Selangor had the highest productivity of paddy production in 2013 at 7.0 t/ha, it was quite lower than the yield target as well. Then, the gap between actual paddy yield and the target in IADA Kemasin Semerak and IADA Kerian Sungai Manik, even was noticeable since both granary areas achieved the actual paddy yield of 2.52 t/ha only and 4.42 t/ha respectively.

In addition, although there have been many efforts and policies in paddy production, there was no significant improvement on the actual paddy yield. In the last five years, national paddy yield grew at 1.30 percent and the growth of paddy yield of granary areas were not more than 10 percent over year. Those conditions conceived that there was a slow growth of actual paddy yield in granary areas of Peninsular Malaysia. Since at a current technology, the yield is normally associated with the input use, the low paddy yield and slow growth of paddy yield is potentially caused by the technical inefficiency in the input use.

Furthermore, the incentive to use more inputs is constrained by the input prices when policy instruments and subsidies for domestic industry including paddy farms should be reduced as expected in the trade liberalization. In this condition, how farmers' response to the input price principally inflames the incentive to use input in the paddy production.

In addition, other important support to encourage farmers increasing the paddy production is Guaranteed Minimum Price (GMP) and price support program. Both supports were reflected in the paddy price and these supports have been applied in eight designated granary areas since 1980. However, to the best of our knowledge, not many estimates on the response of paddy supply to the paddy price and the response of input demand to the input prices have been reported, though practically the paddy farm efficiency depend on this behavior. Hence, based on those problems, this study was conducted to answer the following questions:

1. How does farmer respond the input and output price into the input demand and output supply of paddy?

2. How does production respond the use of inputs and return to scale of paddy farms?

3. What is the current technical and scale efficiency of paddy farms in the granary areas of Peninsular Malaysia?

4. What is the optimal level of production input use in the granary areas of Peninsular Malaysia?

5. What are factors affecting technical efficiency of paddy farms in the granary areas of Peninsular Malaysia?

1.3 Objectives of the Study

The general objective of this study is to analyze the production behavior and the efficiency of paddy farms in granary area of Peninsular Malaysia. The specific objectives of this study are:

1. to determine the input demand elasticity, output supply elasticity, production elasticity and return to scale.

2. to determine the technical efficiency and scale efficiency of paddy farms based on the parametric (stochastic frontier analysis) and nonparametric approaches (DEA and bootstrapped DEA) in order to depict more holistic features of paddy farms' efficiency in Peninsular Malaysia.

3. to determine factors affecting technical efficiency of paddy farms based on farmer's characteristics.

1.4 Significance of the Study

This study provides the information of the production behavior on paddy farms in terms of the input demand and output supply elasticity, production elasticity and its return to scale for eight granary areas in Peninsular Malaysia. These information could be used as a guide for Malaysian authority, policy makers and farming planners in conducting any improving actions that are needed.

Further, the holistic performance of rice farm on each granary area can be clarified through the measurement of existing level of paddy farm efficiency by applying both parametric and nonparametric frontier analysis. Besides, it provides some understanding of factors affecting technical efficiency in paddy production and thereby, policy recommendations could be made from the findings of this study in order to helpfarmers increasing technical efficiency of their paddy farms.

The academic and research contribution of this study is in light of the knowledge of bootstrapping technique on nonparametric approach in order to overcome the sensitivity of those efficiency score since error term is attributed to inefficiency. This study contributes to the literature on the policy debate as to whether the technical inefficiency in input used becomes one of the major causes of low yield in paddy production in Malaysia.

1.5 Organization of the Thesis

This thesis is organized in five chapters. The first chapter discusses in detail the dominant function of paddy farm in Malaysian economy in terms ofits production and consumption. In this chapter, the research problem, objectives and significance of the study is further described.

The explanation about theories relates to the objectives as the main theoretical framework used in this research will be also be discussed in chapter two. This chapter is also enriched by the discussion of the empirical studies on the input demand and output supply responsiveness, and efficiency analysis in the agricultural production.

Chapter three is the methodology, which concentrates on the conceptual framework, model specification and estimation technique. This chapter also discusses on data collection and sampling technique. Then, chapter four presents and interprets the result of the study, which comprises of the descriptive analysis, the empirical estimates of production behavior, the technical efficiency estimation based on parametric and nonparametric approaches that are improved by the bootstrapping technique as well as factors affecting the efficiency.

The final chapter, chapter five, consists of the summary of the research result, which are in line with the research objectives. Besides, policy implication, limitation of study and future research that should be conducted is also suggested in this final chapter.

REFERENCES

_____. (2001). *Paddy Statistics of Malaysia*. Ministry of Agriculture and Agro Based Industry. Malaysia.

_____. (2011). *Agrofood Statistics*. Ministry of Agriculture and Agro Based Industry. Malaysia.

_____. (2013). *Agrofood Statistics*. Ministry of Agriculture and Agro Based Industry. Malaysia.

_____. (2013). *Booklet of Crop Statistics*. Ministry of Agriculture and Agro Based Industry. Malaysia.

Abdullah, N. (2000).The Effects of Price-support Programme on Farm Tenancy Patterns and Farm Profitability: Some Evidence from Malaysia. *The Pakistan Development Review*.39 (1):51-72.

Abdullah, K.B and Ahmad, B. (2006).Technical Efficiency and Its Determinant in Potato Production, Evidence from Punjab, Pakistan. *The Lahore Journal of Economics.* 11 (2):1-22.

Abdullah, Shahzad, K and Khalid,M. (2007). Analysis of Technical Efficiency of Rice Production in Punjab Pakistan. *Pakistan Economic and Social Review*. 45 (2): 231-244.

Abatania, L.N., Atakelty, H. And Amin,W.M. (2012). Analysis of Farm Household Technical Efficiency in Northern Ghana using Bootstrap DEA. *Paper presented at the 56th Annual Cnference of the Australian Agricultural and Resource Society.* The Esplanade Hotel, Freemantle WA, 7-10 February 2012.

Afriat, S.N. (1972). Efficiency Estimation of Production Functions. *International Economic Review* 13(3):568-598.

Aigner,D.J and Chu, S.F. (1968). On Estimating the Industry Production Function. *American Economic Review*. 58(4):826-839.

Aigner, D.J., Lovell, C.A.K. and Schmidt, P. (1977). Formulation and Estimation of Stochastic Frontier Production Function Models. *Journal of Econometrics*. 6: 21-37.

Amaza, P.S, Y.Bila and A.C. Iheanacho. (2006). Identification of Factors that Influence Technical Efficiency of Food Crop Production in West Africa: Empirical Evidence from Borno State, Nigeria. Journal of Agriculture and Rural Development in the Tropics and Subtropics. 107 (2): 139–147.

Balk, B.M. (2001). Scale Efficiency and Productivity Change. *Journal of Productivity Analysis*. 15:159-183.

Banker, R.D., A.Charnes and W.W. Cooper. (1984). Some Models for Estimating Technical and Scale Inefficiency in Data Envelopment Analysis. *Management Science.* 30:1078-1092.

Banker, R.D and R.M.Thrall. (1992). Estimation of Return to Scale Using Data Envelopment Analysis. *European Journal of Operational Research.*62:74-84.

Battese, G.E. and Greg.S. Corra.(1977). Estimation of a Production Frontier Model with Application to the Pastoral Zone of Eastern Australia. *Australian Journal of Agricultural Economics*.21(3): 169-179.

Battese, G.E. (1992). Frontier Production Functions and Technical Efficiency: a Survey of Empirical Applications in Agricultural Economics. *Agricultural Economics*. 7: 185-208.

Battese, G.E and Coelli, T.J. (1992). Frontier Production Function, Technical Efficiency and Panel Data: With Application to Paddy Farmers in India. *Journal of Agricultural Economics.* 21(3):167-179.

Battese, G.E and Coelli, T.J. (1995). A Model of Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. *Empirical Economics.* 20:325-332.

Binam, J., Sylla, K., Diarra, I. and Nyambi, G. (2003). Factors Affecting Technical Efficiency among Coffee Farmers in Coˆ te d'Ivoire: Evidence from the Centre West Region. *African Development Review*, 15:66–76.

Byiringiro, F. and Reardon, T. (1996). Farm Productivity in Rwanda: Effects of Farm Size, Erosion, and Soil Conservation Investments. *Agricultural Economics*. 15: 127-136.

Bravo-Ureta, B.E. and Pinheiro, A.E. (1993). Efficiency Analysis of Developing Country Agriculture: A Review of the Frontier Function Literature. *Efficiency Analysis of Developing Country Agriculture.* 90 April 1993. Pp 88-101.

Chand, R. and J. L. Kaul. (1986). A Note on the Use of the Cobb-Douglas Profit Function. *American Journal of Agricultural Economics.* 68 (1): 162-164.

Charnes,A., Cooper,W.W. and Rhodes, E. (1978). Measuring the Efficiency of Decision Making Units. *European Journal of Operational Research.*2:429-444.

Chaudhary, M.A., Mushtaq, A.K. and Kaukab, H.N. (1998). Estimate of Farm Output Supply and Input Demand Elasticities: The Translog Profit Function Approach. *The Pakistan Development Review.* 37(4):1031-1050.

Chavas, J., Ragan, P and Michael, R. (2005). Farm Household Production Efficiency: Evidence from the Gambia. *American Journal of Agricultural Economics.*87 (1): 160-179.

Chembezi, D.C. (1990). "Estimating Fertilizer Demand and Output Supply for Malawi's Smallholder Agriculture". *Agricultural System.* 33: 293-314.

Christensen, L.R., DW Jorgensen and L.J. Lau. (1973). Transcendental Logarithmic Production Frontier. *Review Economics and Statistics*. 55:28-45.

Coelli, T.J, D.S.Prasada Rao, Christopher, J.O and George E.Battese. (2005).*An Introduction to Efficiency and Productivity Analysis*. 2nd Edition, Springer Science and Business Media, Inc, New York.

Coelli,T.and George,Battese. (1996). Identification of Factors which Influence the Technical Inefficiency of Indian Farmers. *Australian Journal of Agricultural Economics*.40(2): 103-128.

Coelli,T., Sanzidur, R and Colin, T. (2002). Technical, Allocative, Cost and Scale Efficiencies in Bangladesh Rice Cultivation: A Non-parametric Approach. *Journal of Agricultural Economics.* 53(3): 607-626.

Cornwell, C. Schmidt, P and Sickles, R.C. (1990). Production Frontier with Cross Sectional and Time Series Variations in Efficiency Levels. *Journal of Econometrics.* 46(12):185-200.

Debreu, G. (1951). The Coefficient of Resource Utilization. *Econometrica.*19(3): 273-292.

Department of Statistic Malaysia. (2013). Economy and Business. Retrieved November 1, 2013 from http://www.statistics.gov.my/portal/index.php /economy/html.

Diewert,W.E. (1971). An application of the Shephard Duality Theorem: A Generalized Leontief Production Function. *Journal of Political Economics*. 79:481-507

Dhungana, B. R., Peter L. N. and Gilbert V. N. (2004) Measuring the economic inefficiency of Nepalese rice farms using data envelopment Analysis. *The Australian Journal of Agricultural and Resource Economics.* 48 (2): 347–369.

Fisher,B.S. and Charles, A.W. (1990). Supply Response in the Australian Sheep Industry: A Profit Function Approach. *Australian Journal of Agricultural Economics.* 34(2): 147-166.

Farrell, M. J. (1957). The Measurement of Productive Efficiency. Journal of the Royal Statistical Society – Series A (General). 120 (3): 253–290.

Fare, R., Grosskopf, S. Lovell,C.A.K. (1985). *The Measurement of Efficiency of Production.* Kluver-Nijhoff Publishing, Boston.

Fare,R., Grosskopf,S. Lovell,C.A.K. (1994). Production Frontier. Cambridge University Press.

Ferrier, G.D., Hirschberg, J.G. (1997). Bootstrapping Confidence Intervals for Linear Programming Efficiency Scores: With an Illustration Using Italian Bank Data. Journal of Productivity *Analysis.* 8: 19–33.

Gebremedhin, B. and Swinton, S. (2003). Investment in Soil Conservation in Northern Ethiopia: The Role of Land Tenure Security and Public Programs. *Agricultural Economics*. 29: 69–84.

Ghee-Thean, L., M.M.Ismail, and M. Harron. (2012). Measuring Technical Efficiency of Malaysian Paddy Farming: An Application of Stochastic Production Frontier Approach. *Journal of Applied Sciences*, 12 (15) : 1602-1607.

Greene, W.M. (1980). Maximum Likelihood Estimation of Econometric Frontier Functions. *Journal of Econometrics*. 13(1):27-56.

Grosskopf, S. (1996). Statistical Inference and Nonparametric Efficiency: A Selective Survey. *Journal of Productivity Analysis.*7:161-176.

Gocht, A. and Balcombe, K. (2006). Ranking Efficiency Units in DEA Using Bootstrapping an Applied Analysis for Slovenian Farm Data. *Agricultural Economics.* 35(2): 223-229.

Haughton, J. (1986). Farm Price Responsiveness and the Choice of Functional Form: An Application to Rice Cultivation in West Malaysia. *Journal of Development Economics*.24: 203-223.

Helfand, S. M. and Levine, E. S. (2004). Farm Size and the Determinants of Productive Efficiency in the Brazilian Center-West. *Agricultural Economics.* 31(2-3): 241-249.

Huang, Z. and Li, S.X. (2001). Stochastic DEA Model with Different Types of Input-Output Disturbances. *Journal of Productivity Analysis*. 15(2):95-113.

Idiong, I.C. (2007). Estimation of farm level technical efficiency in small scale swamp rice production in Cross River State of Nigeria: A stochastic frontier approach. *World Journal of Agricultural Sciences*. 3(5), 653-658.

Ira´izoz, B. Manuel, R. and Idoia, Z. (2002). Assessing the Technical Efficiency of Horticultural Production in Navarra, Spain. *Agricultural System.* 78: 387-403.

Ismail, M.M, Nurjihan, I., and Behrooz, H. (2013). Technical Efficiency Estimates of Paddy Farming in Peninsular Malaysia: A Comparative Analysis. *Annals of Biological Research,*4(5): 114-118.

Khai, V.H. and Mitsuyasu, Y. (2011). Technical Efficiency Analysis of Rice Production in Vietnam. *Journal of International Society for Southeast Asian Agricultural Sciences.* 17(1): 135-146.

Kim, Y.and Schmidt, P. (2000). A Review and Empirical Comparison of Bayesian and Classical Approaches to Inference on Efficiency Levels in Stochastic Frontier Models with Panel Data. *Journal of Productivity Analysis*. 14:91–118.

Kumar, P., P Shinoj,S.S.R, Anjani, K. , Karl, M.R. and Siwa, M. (2010). Factor Demand, Output Supply Elasticities and Supply Projection for Major Crops of India. *Agricultural Economics Research Review.*23: 1-14.

Kumbhakar, S. C. (1994). Efficiency Estimation in a Profit Maximizing Model Using Flexible Production Function. *Agricultural Economics.* 10:143-152.

Kumbhakar, S. C. and Lovell, C. A. K (2000). Stochastic Frontier Analysis, Cambridge University Press, Cambridge.

Latta,G.S. and Darius, M.A. (2000). An Econometric Analysis of Output Supply and Input Demand in the Canadian Softwood Lumber Industry. *Canadian Journal for Resource*. 30 1419-1428.

Lau, L. J., and P. A. Yotopoulos (1972). A Test of Relative Efficiency and Application to Indian Agriculture. *American Economic Review.* 61: 94-109.

Lau,L.J., and Pan, A.Y. (1972). Profit, Supply and Factor Demand Function. *American Journal of Agricultural Economic*. February 1972:11-18.

Linh, Vu, Hoang. (2012). Efficiency of Rice Farming Household in Vietnam. *International Journal of Development Issues*. 11(1) :60-73.

McFadden, D.L. (1978). "Cost, Revenue and Profit Functions" in an Econometric Approach to Production Theory, EdD.L. M.C. Fadden. Amsterdam, North Holland.

Maganga, A.M. (2012). Technical Efficiency and Its Determinants in Irish potato production: Evidence from Dedza District, Central Malawi. *African Journal of Agricultural Research*. 7(12): 1794-1799.

Maligaya, A.R and Fred, C.W. (1989). Agricultural Output Supply and Input Demand Relationships with Endogenous Land Rents. *Southern Journal of Agricultural Economics*: 13- 20.

Minh, N.K. and Giang, T.L. (2009). Efficiency Estimates for the Agricultural Production in Vietnam: A Comparison of Parametric and Non-parametric Approaches. *Agricultural Economic Review*. 10(2): 62-78.

Murillo-Zamarano, L.R. (2004). Economic Efficiency and Frontier Techniques. *Journal of Economic Surveys*. 18(1): 33-77.

Narala, A. and Zala, Y.C. (2010). Technical Efficiency of Rice Farms under Irrigated Conditions in Central Gujarat. *Agricultural Economics Research Review*. 23:375-381.

Nargis, F and S. H. Lee. (2013). Efficiency Analysis of Boro Rice Production in North Central Region of Bangladesh. *The Journal of Animal and Plant Sciences*. 23 (2):527-533.

Nastis, S.A., Evangelos, P. and Savvas, Z. (2012). Productive Efficiency of Subsidized Organic Alfalfa Farms. Journal of Agricultural and Resource Economics 37(2): 280-288.

Nuthall, P. (2009). Modelling the Origins of Managerial Ability in Agricultural Production. Australian Journal of Agricultural and Resource Economics 53:413-436.

Omondi, S.O and Kelvin, M.S (2013). An Analysis of Technical Efficiency of Rice Farmers in Ahero Irrigation Scheme, Kenya. *Journal of Economics and Sustainable Development*.4 (10): 9-16.

Padilla-Fernandez, M.D and Peter,L.N. (2012). Farms Size and Its Effect on the Productive Efficiency of Sugar Cane Farms in the Central Negros,The Philippines. *Journal of International Society for Southeast Asian Agricultural Sciences*. 18(1):49-61.

Pitt, M.M. and Lee, L.-F. (1981). Measurement and Sources of Technical Inefficiency in the Indonesian Weaving Industry. *Journal of Development Economics*. 9:43-64.

Radam, A and Shamsudin, M.N. (2001). Production Frontier and Technical Efficiency: The Case of Paddy .Farm in Malaysia. *Journal of the Indian Institute of Economy*. 43 : 315-323.

Richmond, J. (1974). Estimating the Efficiency of Production. *International Economic Review*. 15:515-521.

Sadasivam, S. (1993). Price and Non Price Factors in Input Use and Output Supply: A case of Gram in Uttar Pradesh. *Indian Economic Review*. 27(1): 73-83.

Seitz, D.W., Gerald, C.N., and Harold, G.H. (1994). *Economics of Resources, Agriculture and Food*, McGraw-Hill.

Sharma, K.R., Leung, P., Zaleski, H.M. (1997). Productive Efficiency of the Swine Industry in Hawaii: Stochastic Frontier vs. Data Envelopment Analysis, *Journal of Productivity*. 8: 447-459.

Shephard, R.W. (1953). Cost and Production Function, Princeton: Princeton University Press.

Sidhu,S.S and Carlos, A.Baanante. (1981). Estimating Farm Level Input Demand and Wheat Supply in the Indian Punjab Using a Translog Profit Function. *American Journal of Agricultural Economics*. 6(2):237 – 246.

Simar, L and Wilson, P. (1998). Sensitivity Analysis of Efficiency Scores: How to Bootstrap in Nonparametric Frontier Model. *Management Science*. 44 :49-61.

Simar, L and Paul W.Wilson. (2000). A General Methodology for Bootstrapping in Non Parametric Frontier Models. *Journal of Applied Statistics*.27 (6): 779-802.

Singh, S., Amartalingam, R., Wan Harun, W.S. and Islam, M.T. (1996). Simulated Impact of Climate Change on Rice Production in Peninsular Malaysia. Proceeding of National Conference onClimate Change. pp. 41–49, UPM, Malaysia.

Siregar, H. (2007). Elasticities of Output Supply and Input Demand of Indonesian Foodcrops and Their Policy Implication: Multi-input Multi-output Framework. *Socio Economic of Agriculture and Agribusiness*. 7(2): 1-15.

Soli´s, D., Boris E. Bravo-Ureta and Ricardo E. Quiroga. (2009).Technical Efficiency among Peasant Farmers Participating in Natural Resource Management Programmes in Central America. *Journal of Agricultural Economics*. 60(1):202–219.

Srisompun, O. and Somporn, I. (2012). Efficiency Change in Thailand Rice Production: Evidence from Panel Data Analysis. *Journal of Development and Agricultural Economics*. 4(4): 101-108.

Stevenson, R. (1980). Likelihood Functions for Generalized Stochastic Frontier Estimation. *Journal of Econometrics*. 13: 58-66.

Suez, R.R and Shumway, C.R. (1985). Multiproduct Agricultural Supply Response and Input Demand Estimation in the United States: A Regional Profit Function Approach. Technical Report No. 85(3), Texas Experimental Station, Texas and M University.

Tina, W. and Guang H. W. (2000). Technical Efficiency and Its Determinants in China's Grain Production. *Journal of Productivity Analysis*, 13:159-174.

Timmer, C. Peter. (2010). "Reflections on Food Crises Past." *Food Policy*, 35(1): 1-11.

Ullah, R., Shahid, A., Qaisar, S.S., Jamal, S and Kamran, H.K. (2012). Supply Response Analysis of Wheat Growers in District Peshawar Pakistan. *International Journal Latest Agricultural Food Science*.2 : 33-38.

Vengedasalam, D., Michael,H., and Gordon,M . (2011). Malaysia Rice Trade and Government Intervention. Paper presented to the 55th Annual Conference of the Australian Agricultural and Resource Economics Society, Melbourne, 8-11 February 2011.

Vu, H.L. (2012). Efficiency of Rice Farming Households in Vietnam. *International Journal of Development Issues*. 11(1):60-73.

Wadud, A and Ben, W. (2002). The Determinants of Technical Inefficiency of Farms in Bangladesh. *Indian Economic Review, New Series*. 37(2): 183-197.

Wadud, A. (2003). Technical, Allocative, and Economic Efficiency of Farms in Bangladesh: A Stochastic Frontier and DEA Approach. *The Journal of Developing Areas*. 37(1):109-126.

Wilson, P., Hadley, D., and Asby, C. (2001). The Influence of Management Characteristic on the Technical Efficiency of Wheat Farmers in Eastern England. *Agricultural Economics*. 49:329-338.

Wilson, P.W. (2006). FEAR: A Software Package for Frontier Efficiency Analysis with R, Retrieved November 21,2012 from http://www.clemson.edu/faculty/ Wilson/Software/FEAR/fear.html.

Wilson, P.W. (2005), "Frontier Efficiency Analysis with R.FEAR 0.913 User's Guide", Retrieved June 26, 2013 from http: //www.eco.utexas.edu/faculty/ Wilson/Software/FEAR/fear.html.

Yotopoulos, P.A., Lawrence J. L., and Wuu-Long Lin. (1976). Microeconomic Output Supply and Factor Demand Functions in the Agriculture of the Province of Taiwan. *American Journal of Agricultural Economics.* 58(2):. 333-340.