UNIVERSITI PUTRA MALAYSIA

ECONOMIC EFFICIENCY OF RUBBER SMALLHOLDERS IN NEGERI SEMBILAN, MALAYSIA

ALIYU ABDULRAHMAN

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By

ALIYU ABDULRAHMAN

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

January 2017

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DEDICATIONS

It is my genuine gratefulness and warmest regards that I dedicate this work to my late Mother Haj.Hafsah Bello Bekaji and Late Father Alhaji Aliyu Sarkin Yamma.

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

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January 2017

Chairman : Ismail bin Abd Latif, PhD
Faculty : Agriculture

Malaysia is one of the leading producers of natural rubber in the world. About 8.3 % of the total world's rubber is produced in Malaysia. To be precise, Malaysia is currently the third biggest producer of natural rubber in the world and it's the fifth largest consumer of rubber among the world's largest exporters of rubber products (Malaysia Rubber Export Council, 2009). The industry employed more than 300, 000 workers and contributed RM 6.24 billion to the country's export earnings in 2015 (MPIC, 2017). Several studies were carried out on efficiency of rubber production in Malaysia, some studies were on either, allocative or technical efficiency or both (economic efficiency). The present study looked at the economic efficiency and was actually motivated by the fact that efficiency and productivity of Malaysian rubber production has been declining over the years as justified by the preliminary analysis done on nearly 30 year period from 1982-2012. The study therefore, examined not only the possibility of assessing the future survival and strength of rubber productivity in Peninsular Malaysia, but also in a disaggregated form since rubber is a perennial crop. In order to investigate the effects of perenniality on yield and productivity of rubber, both parametric and non-parametric techniques were applied. The determinants or factors militating against the rubber smallholders' efficiency in Negeri Sembilan, Peninsular Malaysia, were also carried out.

Multistage data collection was employed on 327 smallholder farms among 5 districts of Negeri Sembilan state. However, only 307 observations were used in computing inferential statistics, because the young-age category has been removed due to statistically scanty nature of the sample size. The districts include Seremban, Tampin, Rembau, Kuala Pilah and Jempol. Both the descriptive and inferential statistics were thoroughly computed using the appropriate and required statistical tools. The results of the study revealed that the mean rubber yield in kg/ha for the all-age, matured-age and old-age crops categories were 3,638 kg/ha, 4,611 kg/ha and 1,653 kg/ha respectively. The mean technical efficiencies (TE) under Stochastic Frontier Analysis

(SFA) with Cobb-Douglas functional form are 0.70, 0.77, and 0.72 for all-age, matured-age and old-age crops respectively. The mean TE with Translog functional form 0.87, 0.91 and 0.65 respectively for all-age, matured-age and old-age crops. For the non-parametric estimates, the mean TE under variable returns to scale (VRS) and constant returns to scale (CRS) were found to be 0.95, 0.97 0.96 and 0.45, 0.61, 0.33 for the all-age, matured-age and old-age crops respectively. Therefore, this is an indication that matured-age category was found to be relatively higher than the other two age categories in virtually all the methods used. And thus we can conclude that there is quite a difference between the aggregate and disaggregated data. The findings of the study also disclosed that there are actually differences in mean TE between Translog and Cobb-Douglas, DEA and Bootstrapped-DEA, VRS and CRS, DEA and FDH. The result clearly indicated that Translog has higher efficiency scores than the Cobb-Douglas, Mean TE scores under VRS's assumption were higher than those under CRS assumption, and naïve DEA has higher mean scores than bootstrapped-DEA, thus indicating the presence of bias in the former and absence of bias in the later. FDH was also found to have higher mean scores than DEA and this proved the relaxation of convexity assumptions in FDH. Finally, both the VRS and CRS assumptions as well as their respective bias-corrected efficiency scores were also determined using Tobit regression analysis against the 15 socio-demographic factors. It was found out that critical factors, common to all the age-categories, influencing rubber in Malaysia include educational level, tapping system and marital status under both VRS and BC-VRS assumptions, while under both CRS and BC-CRS assumptions include race, tapping system, marital status and farm's distance. Therefore, education of smallholders should be given more attention to increase efficiency. Also tapping system of one-half spiral cut and alternate daily tapping (S/2 d2) should be adopted. However, the findings indicated that increase in farm's distance also increases efficiency. And this translates that nearness to farm leads to reluctance on the part of the smallholders and hence reduces efficiency. This might be true because if a smallholder gets to the farm will easily be reluctant in spending more hours on the farm and will probably be retiring home after working few hours and this reduces performance and hence productivity. Unlike if the farm is relatively far away from home, in which case the farmer would spend more time and hours on the farm and hence improves efficiency.

The study finally recommends that the traditional concept of computing efficiency or productivity of rubber and other perennial crops in an aggregated form should be complemented with the disaggregated form as this eliminates any bias and gives meaningful results as the perennial crops are growing in phases. Improved methods such as bootstrapping should also be used as this only gives what is called bias-corrected efficiency scores. Regarding the determinants, factors such as education, tapping system and farm distance should be given more emphasis. Other policy implications include granting subsidy to the smallholders in terms of fertilizer and chemical herbicides as this helps to cut down the smallholders' production cost and hence improves efficiency. Adequate and skilled training on most of the agronomical practices should be sufficiently and regularly provided at all levels. Most importantly, policy planners should be very cautious on specific techniques. They should as well be knowledgeable and comparatively minded on the results obtained from both parametric and non-parametric assumptions with regards to the policy selections on the rubber crop.

Abstrak tesis ini dipersembahkan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan Untuk Ijazah Doktor Falsafah

KECEKAPAN EKONOMI LADANG PEKEBUN KECIL GETAH DI NEGERI SEMBILAN, MALAYSIA

Oleh

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Malaysia merupakan antara pengeluar utama getah asli di dunia. Lebih kurang 8.3% jumlah pengeluaran dunia dihasilkan dari Malaysia. Malaysia kini adalah pengeluar ketiga terbesar dan kelima terbesar pengguna getah asli di dunia. (Malaysia Rubber Export Council, 2009). Industri ini memberikan peluang pekerjaan kepada 300,000 orang dan menyumbang RM 6.24 billion kepada pendapatan eksport negara pada tahun 2015 (MPIC, 2017). Beberapa kajian telah dilakukan terhadap kecekapan pengeluaran getah Malaysia samaada kecekapan agihan dan/atau kecekapan ekonomi. Kajian ini akan mengkaji semula kecekapan ekonomi pengeluaran getah di sektor pekebun kecil. Kajian ini tercetus memandangkan kecekapan pengeluaran getah yang semakin menurun dari kajian tren selama 30 tahun dari 1982-2012. Kajian ini akan menilai survival masa depan dan kekuatan produktiviti ladang getah menggunakan data mengikut umur pokok menurut profil hasilan getah yang ekonomik selama lebih dari 25 tahun. Kajian juga menggunakan teknik parametrik dan bukan parametrik dalam menilai faktor penentu kecekapan pekebun kecil di Negeri Sembilan, Malaysia.

Pengutipan data secara *Multistage* digunakan terhadap 327 pekebun kecil di lima daerah Negeri Sembilan. Walaubagaimanapun hanya 307 sampel dapat digunakan dalam pengiraan statistik kerana kategori data muda tidak dapat dianalisis disebabkan jumlah saiz yang kecil. Daerah yang terlibat termasuklah Seremban, Tampin, Rembau, Kuala Pilah dan Jempol. Analisis deskriptif dan inferens diaplikasi melalui teknik statistik yang biasa digunakan. Hasil kajian menunjukkan min keluaran getah untuk kategori ladang semua umur, umur matang dan umur tua adalah 3,638 kg/ha, 4,611 kg/ha dan 1,653 kg/ha masing masing. Min kecekapan teknikal kaedah *Stochastic Frontier Analysis* (SFA) spesifikasi *Cobb-Douglas* adalah 0.70, 0.77 dan 0.72 untuk semua ladang, ladang matang dan ladang tua masing masing. Min kecekapan teknikal kaedah spesifikasi *Translog* pula adalah 0.87, 0.91 dan 0.65 untuk semua ladang, ladang matang dan ladang tua masing masing. Untuk kaedah bukan-parametrik, min kecekapan teknikal mengikut pulangan skel berubah dan pulangan skel malar

berjumlah 0.95, 0.97, 0.96 dan 0.45, 0.61, 0.33 untuk semua ladang, ladang matang dan ladang tua masing masing. Jelas ini menunjukkan kecekapan teknikal kategori ladang matang lebih tinggi berbanding ladang keseluruhan dan ladang pokok tua dalam semua teknik penganggaran yang digunakan. Hasil analisis mendapati terdapat perbezaan keputusan antara data agregat (pokok semua umur) dan data yang tidak agregat (pokok matang dan tua). Keputusan kajian juga mendapati perbezaan min kecekapan teknikal antara spesifikasi *Translog* dan *Cobb-Douglas, DEA dan Bootstrapped-DEA, VRS* dan *CRS, DEA* dan *FDH*. Kaedah *Translog* mempunyai skor kecekapan yang lebih tinggi berbanding Cobb-Douglas, skor kecekapan mengikut *VRS* lebih tinggi berbanding *CRS* dan kaedah *naïve DEA* mempunyai skor kecekapan yang lebih tinggi berbanding bootstrapped-*DEA*. Skor kecekapan kaedah *FDH* juga didapati lebih tinggi berbanding kaedah *DEA* kerana tiada tanggapan kecembungan dalam *FDH*.

Analisis lanjutan kedua dua *VRS* dan *CRS* skor kecekapan yang dibaiki bias dianalisis dengan kaedah Tobit dengan 15 faktor sosio-demografik. Hasil kajian ini mendapati faktor kritikal dalam semua kategori umur yang mempengaruhi kecekapan pengeluaran getah ialah tahap pendidikan, sistem torehan dan status perkahwinan dibawah tanggapan *VRS* dan *BC-VRS*. Manakala mengikut tanggapan *CRS* dan *BC-CRS*, faktor utama yang mempengaruhi kecekapan adalah bangsa, sistem torehan, status perkahwinan dan jarak ladang dengan rumah pekebun kecil. Hasil kajian menekankan kepada factor pendidikan pekebun kecil, sistem torehan dan jarak rumah dengan ladang akan mampu meningkatkan kecekapan. Ladang yang jauh dari rumah akan memastikan pekebun lebih lama di ladang daripada pulang awal berbanding dengan jarak ladang dengan rumah yang dekat. Ini akan meningkatkan lagi kecekapan ladang yang lebih jauh dari rumah supaya tidak merugikan masa dan tenaga jika pulang awal.

Kajian mengunjurkan konsep pengiraan kecekapan tradisional diapplikasi dengan data agregat dan tidak agregat supaya bias dalam pengiraan dapat dikurangkan, memandangkan pokok saka mempunyai tahap yang berbeza dalam pertumbuhannya. Kaedah lain seperti *bootstrapping* juga patut digunakan dalam mendapatkan skor kecekapan yang tidak bias. Faktor penentu kecekapan pula seperti pendidikan, sistem torehan dan jarak rumah dengan ladang patut ditekankan kerana faktor tersebut akan menyumbang kepada peningkatan kecekapan ladang pekebun kecil.

Implikasi polisi yang lain termasuklah memberi bantuan subsidi kepada pekebun kecil dalam bentuk baja dan racun rumpai kerana ini akan mengurangkan kos pengeluaran dan meningkatkan kecekapan. Latihan kepakaran dalam aktiviti agronomi mesti sentiasa ditawarkan kepada pekebun kecil di semua tahap pertumbuhan pokok getah. Perancang polisi juga harus memahami kebaikan dan keburukan teknik empirik fungsi pengeluaran. Pengetahuan serta pemahaman tentang perbezaan keputusan dari tanggapan parametrik dan bukan parametrik harus di ambil kira dalam pemilihan sesuatu polisi pertanian yang lestari dan wajar dengan tanaman getah.

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I certify that a Thesis Examination Committee has met on 6 January 2017 to conduct the final examination of Aliyu Abdulrahman on his thesis entitled "Economic Efficiency of Rubber Smallholders in Negeri Sembilan, 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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Date: 28 April 2017

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

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Signature: _____
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AE	Allocative Efficiency
ATE	Average Technical Efficiency
BCC	Banker, Cooper and Charnes Model
CCC	Charnes, Cooper and Rhodes Model
CE	Cost Efficiency
CD	Cobb Douglas Production Function
COA	Conditional Oder Alpha
CRS	Constant Return to Scale
DEA	Data Envelopment Analysis
DEA-B	Bootstrapped-DEA
DGP	Data Generating Process
DMU	Decision Making Unit
DOS	Department of Statistics
DRS	Decreasing Return to Scale
EE	Economic Efficiency
EOM	Expected Oder M
FAO	Food And Agricultural Organization
FDH	Free Disposal Hull
FEAR	Frontier Efficiency Analysis with R
IRSG	International Rubber Study Group
IRTS	Increasing Return to Scale
MLE	Maximum Likelihood Estimates
MREC	Malaysian Rubber Export Council
MT	Metric Tonnes
NR	Natural Rubber
NIRTS	Non-increasing Return to Scale
ODEA	Output Data Envelopment Analysis
OLS	Ordinary Least Square
OTE	Overall Technical Efficiency
RISDA	Rubber Industry Smallholders Development Authority
SD	Standard Deviation
SE	Scale Efficiency
SFA	Stochastic Frontier Analysis
TE	Technical Efficiency
TR	Translog Production Function
UK	United Kingdom
USA	United States Of America.
VRS	Variable Return to Scale

CHAPTER 1

INTRODUCTION

1.1 Overview of Rubber Production in Malaysia and the Wider World.

Natural Rubber (NR) which is scientifically or botanically known as *Havea Brazilensis* was initially planted at Kuala Kangsar, in Malaysia in 1877 after its arrival from Kew Garden in England. About 10 years later, a large or commercial scale production was developed by the Malaysian government under the then director of Botanical Garden in Singapore and Penang in person of Mr. Henry Ridley (Othman. A, 2008). The process of large scale production has continued and by 1967, technically specified rubber was invented known as Standard Malaysian Rubber (SMR) and in 1977 when rubber plantation production has turned 100 years in existence, the contribution of Henry Ridley who was equally called a "father of rubber industry in Malaysia", was not left unrecognized . Specifically, the gesture was reciprocated by Malaysian Rubber Producers' Council for his immense contribution to rubber development in Malaysia.

The production of rubber is normally termed "Tapping" or more clearly called "Rubber tapping". And this basically refers to a situation in which the rubber trunk or the back of a rubber tree is deliberately, systematically and in a controlled pattern, got wounded and subsequently milk-like liquid called "latex" oozes out in to an already attached collection cup. Depending on the taping system, the process occurs either daily or on alternate days with v-shaped or spirally-shaped cuts. Also depending on how fast and quick the accessible rubber tree trunk is re-generated, the tapping processes continue for about twenty (20) years, once it has commenced (Giroh, D.Y et al, 2012). The collected milk-like latex liquid are emptied in to larger containers mixed with liquid ammonium to serve as anticoagulants (to prevent coagulation of latex) and then eventually driven to rubber factories where they are weighed, heat-dried and reweighed again to measure the kg of the dried rubber output (Son T.V.H et al ,1993).

Malaysia is one of the leading producers of natural rubber in the world. About 8.8% of the total world's rubber is produced in Malaysia. To be precise, Malaysia is currently the third biggest producer of natural rubber in the world and it's the fifth largest consumer of rubber among the world's largest exporters of rubber products (Malaysia Rubber Export Council, 2009). Malaysia's natural rubber production in 2015 amounted to 0.72 million tonnes compared with 0.94 million tonnes in 2010. The industry employed more than 300,000 workers and contributed RM 6.24 billion to the country's export earnings in 2015 (MPIC, 2017). Malaysia's Vision 2020 sets out new goals for the Malaysian rubber industry to enhance productivity and competitiveness, and to modernize the predominant smallholders sector in order to maximize the industry's contribution to the national economy.

Malaysian rubber products are being exported to virtually more than 190 different countries across the globe. Figure 1.1 revealed that three countries which comprised of the United States, Germany and Japan are actually the three largest market distributions for the Malaysian rubber products. This is true as 6% each of Germany and Japan with the 29% from USA, the three countries share of rubber product export from Malaysia accounted for approximately 41%. Other countries serving as potential rubber export partners to Malaysia include China, United Kingdom (UK) and Australia.

Malaysia, being a global rubber player, is the seventh country among the top ten world rubber consuming countries in both natural and synthetic rubber. Other high rubber consuming countries include China, The USA, Japan, India, Thailand, Indonesia, Germany, Brazil and the Republic of Korea (MREC, 2016).

Although, the Malaysian rubber production capacity has increased from 0.67 million tonnes in 2014 to 0.70 million tonnes in 2015 and this is by almost 4.1%, but Malaysia still retains a fifth position in among the world largest rubber producing countries. The other top ranking global rubber producing nations include Thailand, Indonesia, Vietnam and China. In terms of export, although it still remains a net natural rubber exporter, but the NR export from 2014 to 2015 has suffered a decline of about 5.4% (MREC, 2016).

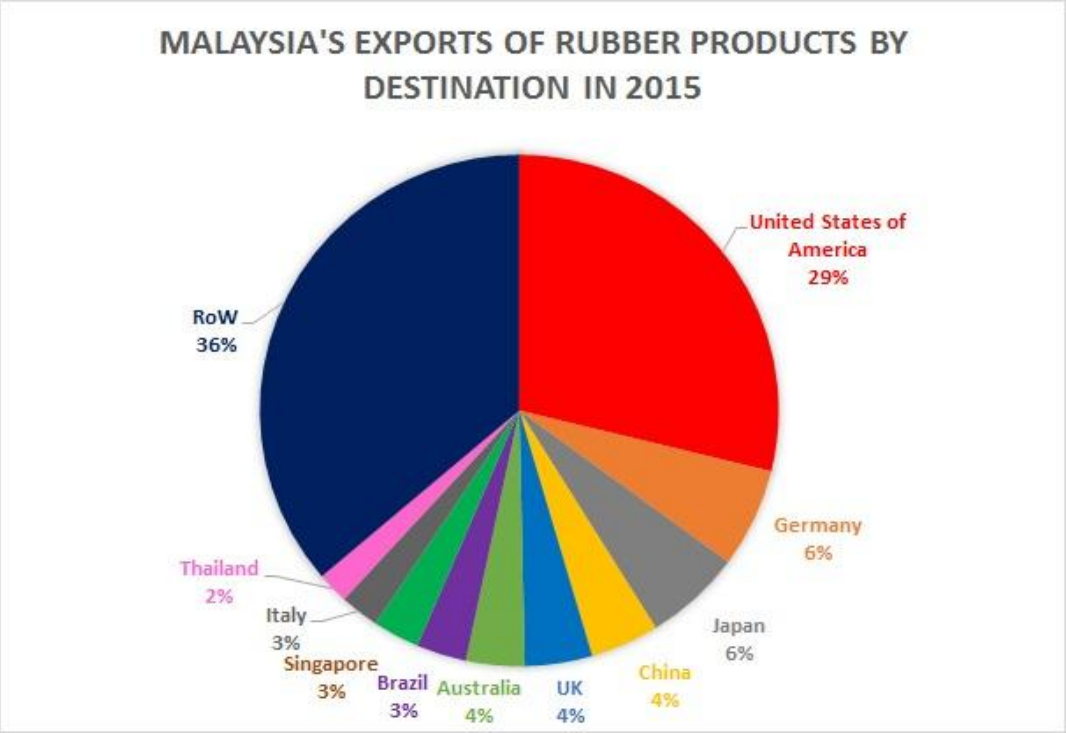

Figure 1.1: Malaysia's export of rubber products by destination in 2015.
(Source: Department of Statistics, Malaysia.)

Table 1.1 below presents rubber productions by the world major rubber-producing countries. These figures were extracted from the Statistics of Food and Agricultural Organizations (FAO, 2013). The table disclosed that Malaysia is the third largest rubber producing country headed by Thailand and Indonesia which are the first and second largest respectively. Nearly one million metric tonnes which constitutes about 9% of world total rubber production is coming from Malaysia alone. This is followed by India and Vietnam whose rubber production capacities stood at respectively 7.9% and 7.0% of the world total rubber productions.

Table 1.1: Top Five (5) World major rubber-producing countries

S/no	Countries	Production (mt)	% of world production	% Δ from 2010
1	Thailand	3,348,897	29	9.73
2	Indonesia	3,088,400	27.3	12.92
3	Malaysia	996,673	8.8	10.86
4	India	891,344	7.9	3.4
5	Vietnam	789,635	7	5.04

Source: FAOSTAT, 2013

Malaysian total rubber productivity as well as productivity for both the smallholders and rubber estates are presented in tables 1.2, 1.3 and 1.4 respectively, while the graphical representations of each of the productivity tables are presented in figures 1, 2 and 3 for the total, smallholders and estates respectively.

Starting with table 1.2 which is the total productivity or yield of Malaysian rubber, consists of the values of both the estate and the smallholders productivity combined. About 30 year time series data drawn from statistics department of Malaysia displayed 4 columns which include total area planted in hectares, total production in tonnes, and total productivity in tonnes per hectare as well as total productivity in kilogram per hectare for 30 years from 1982 until 2012. A careful observation of the table indicated that Malaysian rubber yield productivity has increased especially during the period between 2004 to 2007, with 2006 as the most lucrative year Malaysia ever experienced in terms of rubber productivity having an estimated quantity of 1,216 kg/ha which is equivalent to 1,.34 million tonnes per hectare.

However, the rubber productivity started declining again shortly after 2007. This decline in productivity trend might be as a result of decrease in production capacity. This is because as can be seen from the table, that the total rubber planted area was increasing from 2009 until 2012, yet productivity was coming down. So regarding this trend, the rubber yield productivity is going in a direct proportion with production but partly in an inverse proportion with planted area. So summing it up, the rubber yield is declining was due to among other things, low production capacities which in turn might be affected due to other influencing factors.

Table 1.2: Malaysian total rubber productivity for the period 1982-2012

Years	Area (000 ha)	Production (000 MT)	Productivity (Mt/ha)	Productivity (Kg/ha)
1982	1,991.6	1,494.1	0.75	680.57
1983	1,971.0	1,563.7	0.79	719.72
1984	1,972.7	1,530.6	0.78	703.88
1985	1,955.4	1,469.4	0.75	681.71
1986	1,912.0	1,538.6	0.80	730.02
1987	1,881.3	1,578.7	0.84	761.27
1988	1,865.8	1,661.6	0.89	807.90
1989	1,849.0	1,415.6	0.77	694.55
1990	1,836.7	1,291.0	0.70	637.66
1991	1,818.7	1,255.7	0.69	626.36
1992	1,792.3	1,170.9	0.65	592.66
1993	1,762.8	1,074.3	0.61	552.87
1994	1,737.1	1,100.6	0.63	574.78
1995	1,688.8	1,087.5	0.64	584.18
1996	1,644.3	1,082.3	0.66	597.12
1997	1,616.5	971.1	0.60	544.99
1998	1,543.6	883.5	0.57	519.24
1999	1,464.8	777.8	0.53	481.71
2000	1,430.7	926.2	0.65	587.29
2001	1,389.3	882.0	0.63	575.93
2002	1,065.9	890.0	0.83	757.48
2003	1,021.3	985.7	0.97	875.57
2004	976.6	1,168.6	1.20	1085.54
2005	957.8	1,126.0	1.18	1066.50
2006	957.1	1,283.6	1.34	1216.66
2007	976.2	1,199.6	1.23	1114.80
2008	986.2	1,072.4	1.09	986.48
2009	1,015.1	857.0	0.84	765.90
2010	1,015.2	939.2	0.93	839.28
2011	1,012.8	996.2	0.98	892.32
2012	1,059.7	922.8	0.87	789.99

Source: Malaysian Department of Statistics, (2015)

The values in the fourth column of table 1.2 which represents the total productivity in kg/ha, are presented in form of a line graph. The statistical trend of almost 30 years of time series data ranging from 1982-2012, was plotted using the figures of the table 1.2.which in turn sourced from the Malaysian department of statistics. The figure also revealed that rubber productivity have initially increased, then maintained a fairly stable flow, increased to a certain level and thereafter started to decline.

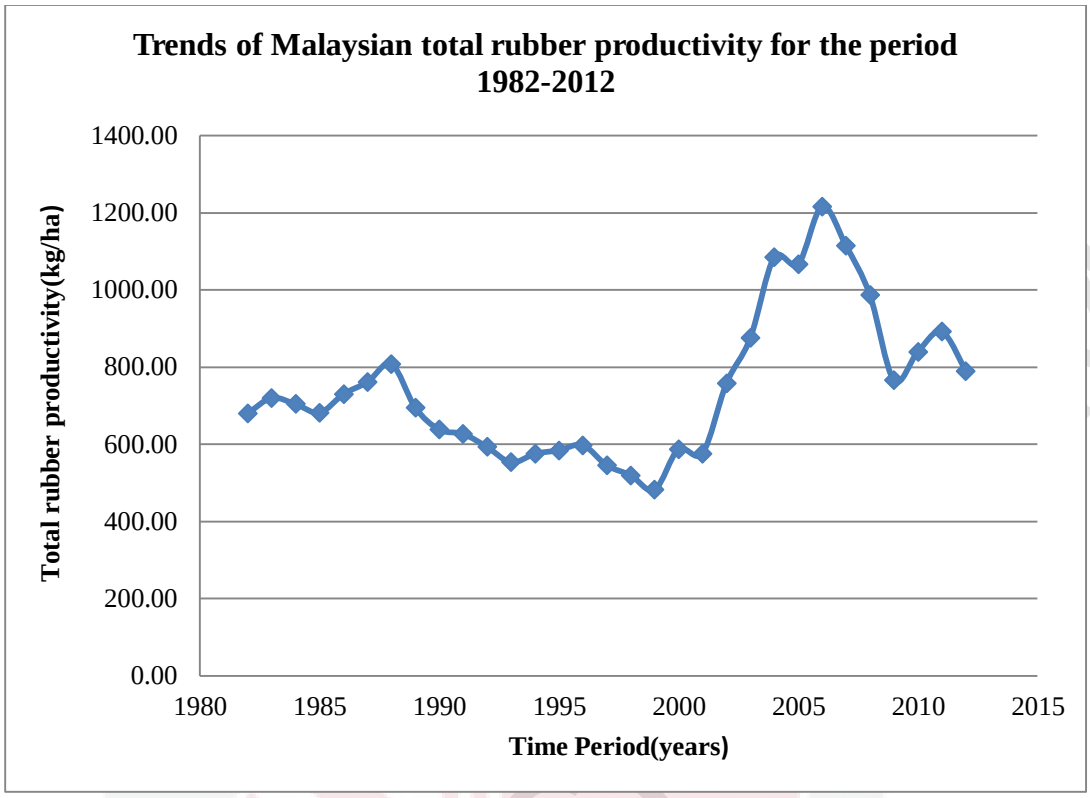

Figure 1.2: Trends of Malaysian Total rubber productivity for the period 1982-2012. (Source: Department of Statistics, Malaysia)

The yield productivity of smallholders both in tonnes and in kilogram are presented in Table 1.3 as well as the planted area and the output of production. In fact both the values in Table 1.3 as well as the graphical trend of the smallholder's productivity in Figure 1.3 have shown almost and virtually the same pattern of movement with the total productivity in table 1.2 and the total productivity trend in Figure 1.2 This means the only disparity between the total productivity and the productivity of the smallholders is just in magnitude, but the pattern is almost the same. This is because in the smallholders' section, the productivity also maintains fairly same increment, but increased to its zenith level during the period of 2004-2007 and thereafter declines as the years progressed to 2012.

Table 1.3: Malaysian rubber smallholders' productivity for the period 1982-2012

Years	Area (000 ha)	Production (000 MT)	Productivity (Mt/ha)	Productivity (Kg/ha)
1982	1,509.7	931.9	0.62	559.99
1983	1,493.5	1,016.2	0.68	617.27
1984	1,517.9	1,012.5	0.67	605.13
1985	1,526.6	965.1	0.63	573.52
1986	1,512.7	1,041.1	0.69	624.36
1987	1,499.8	1,088.1	0.73	658.16
1988	1,494.7	1,180.5	0.79	716.49
1989	1,488.0	982.8	0.66	599.18
1990	1,488.0	894.4	0.60	545.29
1991	1,485.3	889.4	0.60	543.23
1992	1,478.2	837.9	0.57	514.23
1993	1,470.3	778.0	0.53	480.03
1994	1,462.1	829.3	0.57	514.56
1995	1,433.1	846.8	0.59	536.05
1996	1,420.4	844.4	0.59	539.31
1997	1,415.8	755.2	0.53	483.90
1998	1,363.7	686.8	0.50	456.89
1999	1,313.6	594.7	0.45	410.71
2000	1,306.9	799.5	0.61	554.98
2001	1,293.8	782.5	0.60	548.68
2002	981.1	805.0	0.82	744.36
2003	942.9	909.3	0.96	874.86
2004	912.2	1,097.5	1.20	1091.47
2005	899.1	1,060.7	1.18	1070.24
2006	902.9	1,215.2	1.35	1220.97
2007	923.5	1,134.1	1.23	1114.07
2008	935.3	1,012.8	1.08	982.36
2009	965.4	800.2	0.83	751.95
2010	965.3	883.2	0.91	830.03
2011	962.9	943.2	0.98	888.63
2012	993.8	864.0	0.87	788.70

Source: Malaysian Department of Statistics, (2015)

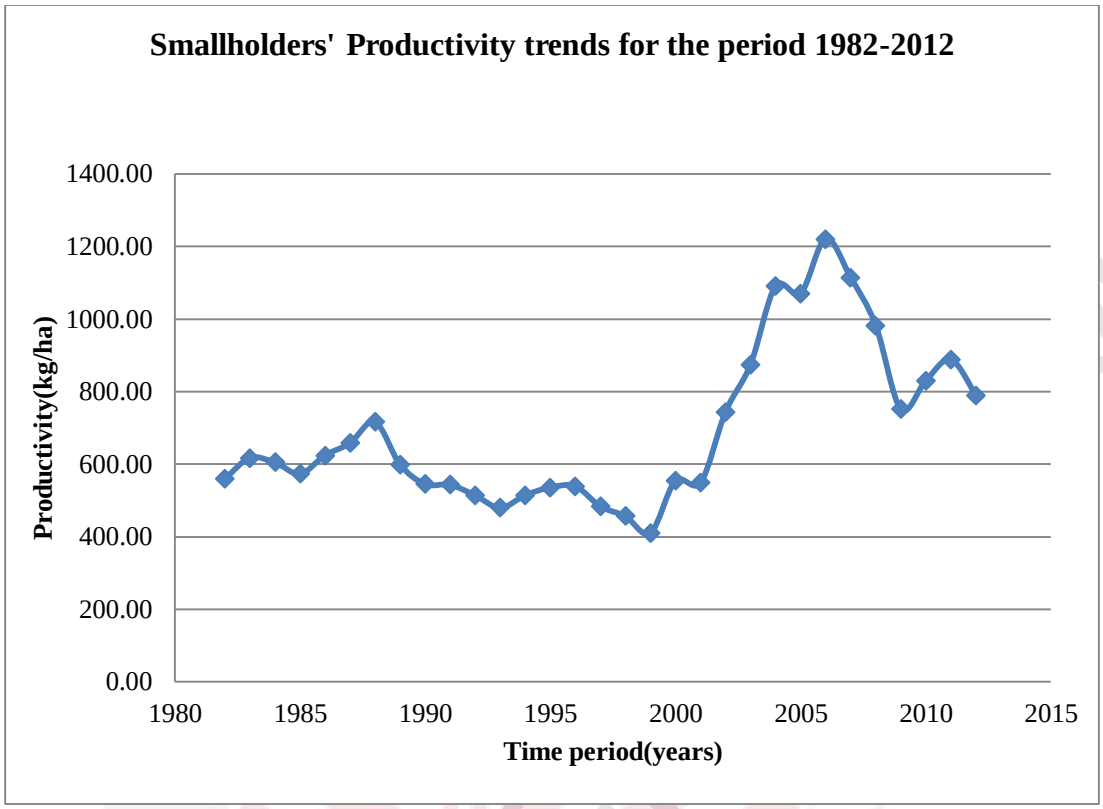

Figure 1.3: Smallholders Rubber Productivity Trend for the Period 1982-2012
(Source: Malaysian Department of Statistics, (2015))

Table 1.4 presents the Malaysian estates rubber productivity, while Figure 1.4 revealed the productivity trend of the rubber estates in kilogram per hectare. The estates yield productivity trend in Figure 1.4 is not like the previous two trends in Figures 1.2 and 1.3. The flow of the trend as shown in Figure 1.4 has more of haphazard and ups and downs fluctuations than both the total productivity trend and that of the smallholders' trend in Figures 1.2 and 1.3 respectively. This is an indication that the largest portion of rubber farmers in Malaysia is a smallholder. That means rubber smallholders outnumbered the rubber estate plantation holders. This could be one of the likely reasons the present study concentrated and gave more emphases on having smallholders as the target for the research than the estates plantations.

Table 1.4: Malaysian Rubber Estates' Productivity from 1982-2012

Years	Area (000 ha)	Production (000 MT)	Productivity (Mt/ha)	Productivity (Kg/ha)
1982	481.9	562.2	1.17	1058.36
1983	477.5	547.5	1.15	1040.18
1984	454.8	518.1	1.14	1033.45
1985	428.8	504.3	1.18	1066.92
1986	399.4	497.5	1.25	1130.01
1987	381.5	490.6	1.29	1166.62
1988	371.1	481.1	1.30	1176.10
1989	361.0	432.8	1.20	1087.62
1990	348.7	396.6	1.14	1031.81
1991	333.4	366.2	1.10	996.44
1992	314.1	333.0	1.06	961.78
1993	292.5	296.3	1.01	918.98
1994	275.0	271.3	0.99	894.98
1995	255.7	240.7	0.94	853.97
1996	223.9	237.9	1.06	963.91
1997	200.7	215.9	1.08	975.90
1998	179.9	196.7	1.09	991.91
1999	151.2	183.1	1.21	1098.59
2000	123.8	126.7	1.02	928.44
2001	95.5	99.5	1.04	945.19
2002	84.8	85.0	1.00	909.33
2003	78.4	76.4	0.97	884.05
2004	64.4	71.1	1.10	1001.57
2005	58.7	65.3	1.11	1009.19
2006	54.2	68.4	1.26	1144.87
2007	52.7	65.5	1.24	1127.53
2008	50.9	59.6	1.17	1062.25
2009	49.7	56.8	1.14	1036.79
2010	49.9	56.0	1.12	1018.09
2011	49.9	53.0	1.06	963.55
2012	65.9	58.8	0.89	809.45

Source: Malaysian Department of Statistics, (2015)

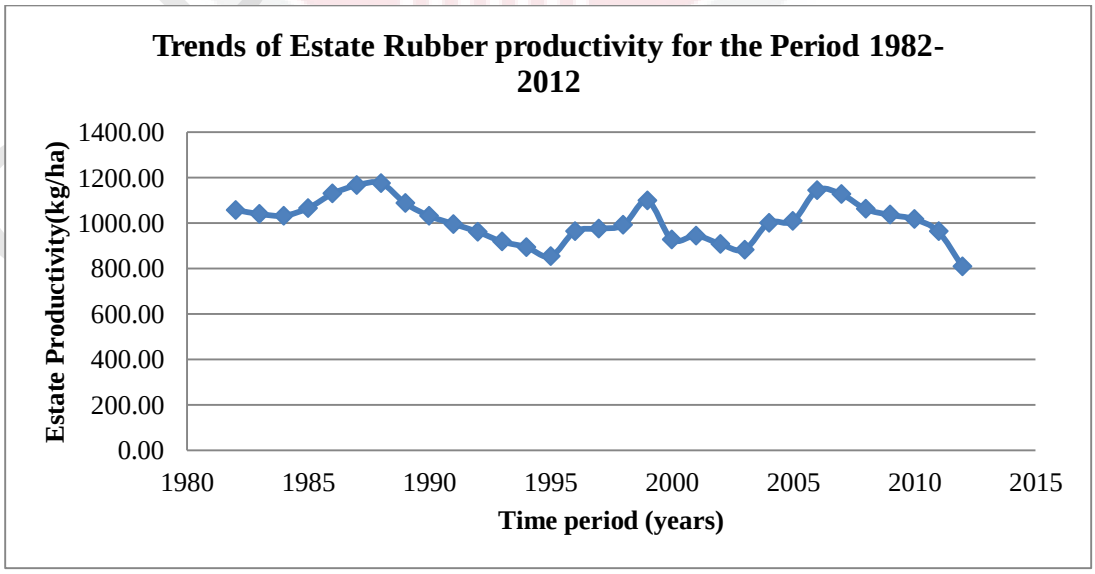

Figure 1.4: Productivity Trends of Estate Productivity for the Period 1982-2012
(Source: Department of Statistics, Malaysia (2015))

Table 1.5 presents the global production and consumption of natural rubber in thousand tonnes for sixteen year period from 2000-2015. The production trend has been increasing from 2000 to 2008 and had a sharp decline in 2009 and thereafter started rising again in 2010. Therefore, the trend has increased by almost 53% over the 10 year period from approximately 6.8 million tonnes in 2000 to 10.4 million tonnes in 2010. From 2010, the world rubber production capacity has started increasing again to 11.2 million, 11.7 million and 12.3 million tonnes in 2011, 2012 and 2013 respectively. It has however, declined to 12.1 million tonnes in 2014 and then regained its position back to 12.3 million tonnes in 2015.

Table 1.5 : World Rubber Production and Consumption from 2000-2015 in '000 MT

Year	Production	Consumption
2000	6,811	7,108
2001	6,913	7,039
2002	7,317	7,515
2003	7,986	7,797
2004	8,726	8,562
2005	8,921	9,049
2006	9,850	9,513
2007	10,057	10,138
2008	10,098	10,187
2009	9,723	9,289
2010	10,403	10,792
2011	11,239	10,997
2012	11,658	10,013
2013	12,281	11,430
2014	12,111	12,134
2015	12,267	12,348

Source: International Rubber Study Group (IRSG) 2016.

In summary, the world rubber production has increased by nearly 81% from 2001 when it was only 6.8 million tonnes to 2015 when it became 12.3 million tones, thus having a difference of 5.5 million tones and this equals to 81% increase.

The second column in the table displayed the figures in thousand tonnes of the world natural rubber consumption for a period of sixteen (16) years. Although it is relatively different in terms of magnitude, but the consumption trend is similar to that of the production trend in such a way that, it has also started increasing from 2000 to 2008, declined in 2009 and rose again in 2010 just like the production trends' pattern.

The percentage increase in consumption trend from 2001 to 2009 is also 52%, almost similar to 53% increase in production for the same10 year period. The consumption trend further increased to 11.4 million tonnes in 2013, through 12.2 million tonnes in 2014 and finally to 12.4 million tonnes in 2015. Therefore, the percentage increase in consumption for 2001-2015 was found to be 75% which is comparatively lower than 81% increase in production capacity for the same sixteen year period.

1.2 Number and Planted Area of Rubber Smallholders by States

Table 1.6 presents a comprehensive number of various smallholders in each state of Malaysia and their respective percentages. It is a known fact that Malaysia consists of the West and the East Malaysia, with the West Malaysia sometimes called Peninsular Malaysia and the East Malaysia composed of the Sarawak and Sabah States.

A closed observation of the above table reveals that Sarawak and Sabah consist of 20.4% and 11.6% respectively, and this equals about 32% of the smallholders in the entire Malaysia as a country. This translates that Peninsular Malaysia has 68% of the total smallholders.

Kelantan State which has about 43,763 smallholders is the highest State with smallholders in Peninsular Malaysia. This is followed by Kedah, Pahang, Perak and Negeri Sembilan with percentages of smallholders as 12.1%, 9.8%, 7.6% and 7.1 respectively. Negeri Sembilan, which happened to be the study area of this research, has approximately 20,027 rubber smallholders. According to recent report from Rubber Industry Smallholder Development Authority (RISDA), the total number of rubber smallholders in the entire Malaysia, is 283,683 (RISDA, 2015).

However, of this figure, ninety thousand seven hundreds and ninety two (90,792) rubber smallholders are from Sarawak and Sabah. Therefore, this implies that a total of one hundred and ninety two thousand, eight hundred and ninety one (192,891) smallholders are from Peninsular Malaysia.

Table 1.6: Distribution of Rubber Smallholders by States

S/no	State	No of Smallholders	Percentage (%)
1	Sarawak	57,909	20.4
2	Kelantan	43,763	15.4
3	Kedah	34232	12.1
4	Sabah	32,883	11.6
5	Pahang	27,872	9.8
6	Perak	21,688	7.6
7	Negeri.Sembilan	20,027	7.0
8	Johor	17,980	6.3
9	Terengganu	12,809	4.5
10	Melaka	6,672	2.4
11	Selangor	3,985	1.4
12	Perlis	3,138	1.1
13	Pulau Pinang	725	0.3
	Total	**283,683**	**100**

Source: RISDA, 2013

1.3 Area (Ha) and percentage of Rubber Smallholders by States

The table 1.7 below presents the cultivated, planted areas of rubber smallholders and their respective percentages. A closer look at the table revealed that a total planted area of 621,269.72 ha have been used by rubber smallholders in the entire country of Malaysia. 38.7% of the amount is from Sarawak and Sabah, while the remaining 61.3% is allocated to peninsular Malaysia. Although Sarawak and Sabah have their highest planted area among all the thirteen (13) States, but Kelantan, Kedah, Pahang and Negeri Sembilan are the four (4) leading states with high number of planted areas in peninsular Malaysia. For instance, Kelantan has about eighty one thousand, eight hundred and fifty two (81,852) hectares, and this is 13.2% of the total planted area in Malaysia but is equivalent to 21.50% in peninsular Malaysia. Also Kedah, Pahang and Negeri Sembilan with a cultivated areas of 67,214, 64,080 and 46,669; have respectively 10.8%, 10.3% and 7.5% in regards to entire Malaysian country. But taking only peninsular Malaysia with a total planted area of 380,765 hectares. The Kedah, Pahang and Negeri Sembilan States have their respective percentages of planted areas as 17.7%, 16.8% and 12.3% respectively.

Other remaining states include Johor, Terengganu, Melaka, Selangor, Perlis and Pulau Pinang. Selangor and Pulau Pinang have the least percentages of planted areas as 0.9% and 0.2% respectively.

Table 1.7: Area and percentage of Rubber smallholders by States

S/no	State	Planted area (ha)	Percentage (%)
1	Sarawak	138,005.70	22.2
2	Kelantan	81,852.56	13.2
3	Kedah	67,214.00	10.8
4	Sabah	102,498.21	16.5
5	Pahang	64,080.56	10.3
6	Perak	37,019.06	6
7	Negeri Sembilan	46,669.93	7.5
8	Johor	33,978.24	5.5
9	Terengganu	24,059.09	3.9
10	Melaka	11,480.08	1.8
11	Selangor	5,614.00	0.9
12	Perlis	7,633.30	1.2
13	Pulau Pinang	1,165.00	0.2
	Total	**621,269.72**	**100**

Source: Department of Statistics, Malaysia (2015)

1.4 Production, Imports, Exports and Consumption of Malaysia's Natural Rubber

Table 1.8 Presents the Malaysian total production, imports and exports, as well as amount of natural rubber consumed in recent years from 2000-2015 periods. Throughout the 16 years period only a single year in which the country imported more than one(1) million tonnes of rubber product. While in terms of volume of export, the country has been exporting rubber products of more than I million tonnes from 2004 until 2015. However, domestic consumption has not been recorded with a magnitude of more than 0.5 million tonnes. All the consumption records have been less than ½ million tonnes for each year. In fact the highest quantity of rubber consumed in the country in recent years, was 474,773 tonnes and this was in the year 2015. Concerning the quantities or volumes of imports and exports, the highest quantity recorded were 1,004,805 and 1,348,451 respectively and both of these occurred in the year 2013.

Table 1.8: Malaysian Imports, Exports and Consumptions of Rubber from 2000-2015 (MT)

Year	Production	Imports	Exports	Consumptions
2000	927,608	548,234	977,978	363,715
2001	882,067	475,675	820,854	400,888
2002	889,832	456,866	887,019	407,884
2003	985,647	436,552	946,475	421,781
2004	1,168,735	425,627	1,109,130	402,769
2005	1,126,023	461,857	1,154,745	386,472
2006	1,283,632	513,603	1,287,043	383,324
2007	1,199,553	605,120	1,209,748	450,246
2008	1,072,365	521,873	1,163,538	468,894
2009	857,019	738,758	1,082,547	468,669
2010	939,241	706,250	1,244,386	457,919
2011	996,210	668,442	1,253,646	401,923
2012	922,798	872,429	1,303,029	441,398
2013	826,421	1,004,805	1,348,451	434,192
2014	668,613	905,039	1,190,999	448,484
2015	722,122	957,300	1,112,614	474,773

Source: Department of Statistic Malaysia (DOSM

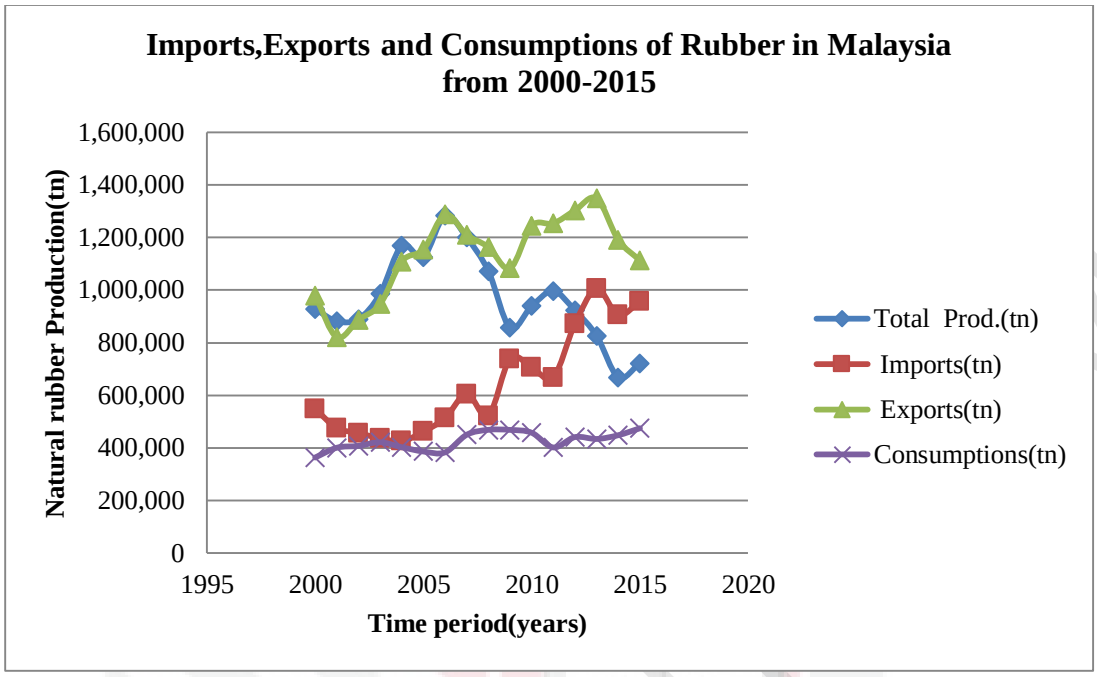

Figure 1.1: Malaysian Rubber Imports, Exports and Consumptions trends
(Source: Department of Statistic Malaysia (DOS, 2015))

1.5 Malaysian Rubber Imports Partners

The table 1.9 below consist of various natural rubber imports figures which Malaysia imported from five of her major rubber import partners in the period spanning from 2011-2015. The five countries, from which Malaysian governments import rubber to supplement her own production, include mostly Asian countries such as the neighboring republic of Thailand, Indonesia, Myanmar, Philippines and Vietnam. Thailand takes a major import quantity of almost more than half of the country's rubber import in tonnes. For instance, about 407,353 tonnes of rubber were imported from Thailand alone and this constitutes about 61% of Malaysia's volume of annual rubber import in year 2011. Also in 2012, 2013, 57.2% and 51.3% rubber quantity were imported from the Kingdome of Thailand alone. The second country in terms of the volume of the importation is Vietnam followed by Philippines, Myanmar, and finally the republic of Indonesia. Of the 84.4% imported from these countries alone in 2011, 60.9% was from Thailand, 9.6% from Vietnam, 8.1% from Philippines and 3.2% and 2.6% were from Myanmar and Indonesia respectively. Also in 2012, Thailand took a leading position with 57.2% out of the 85.8% from the five countries put together. 19.3% was from Vietnam while Philippines, Myanmar and Indonesia respectively got 5.9%, 2.2% and 1.2%. In fact, Thailand and Vietnam continued to take a leading role in terms of volume of importation into Malaysia throughout the five years period ranging from 2011 to 2015. In 2013, Thailand has 51.3% while Vietnam contributed 23%. In 2014 Thailand contribution has declined to 48.7%, while that of Vietnam has increased to 25.4%

Table 1.9: Malaysian Rubber Imports Partners

Country	2011tones (%)	2012 tones (%)	2013 tones (%)	2014 tones (%)	2015 tones (%)
Thailand	407,353(60.9)	498,612(57.2)	515,284(51.3)	441,117(48.7)	506452(52.9)
Vietnam	64,471(9.6)	168,210(19.3)	231151(23)	229,951(25.4)	188,531(19.7)
Philippine	53855(8.1)	51387(5.9)	57,289(5.7)	59,100(6.5)	66,115(6.9)
Myanmar	214069(3.2)	19,117(2.2)	27,355(2.7)	16,339(1.8)	25,503(2.7)
Indonesia	17,069(2.6)	10,503(1.2)	10,431(1.0)	9,501(1.0)	4,706(0.5)
Other	104,288(15.6)	124,602(14.2)	163295(16.3)	149,031(16.6)	165993(82.7)
Total	**668,442(100)**	**872,429(100)**	**1,004,805(100)**	**905,039(100)**	**957,300(100)**

Source: Department of Statistics, Malaysia (2015)

1.6 Malaysia's Export of Natural Rubber by Destinations

Table 1.10 presents five (5) strong natural rubber export partners to which Malaysia's rubber produce are being exported in recent years. The table clearly extracted five major countries that imports rubber from Malaysia. These countries include People's Republic of China, Germany, Iran, United States and South Korean republic. Out of the five (5) countries, two are from the west, two are from the East and one is from Middle East. A closer look at the export figures, it would be observed that more than half of the Malaysian natural rubber productions are being exported to People's Republic of China. In all the five years (from 2011-2015), the people's republic of China has gulped more than 50% of Malaysia's natural rubber export. Following China, Germany is the second in terms of quantity of rubber output going in to Germany is approximately 9%. The republic of Iran, USA and South Korean republic are also importing appreciable quantity of rubber from Malaysia. In fact, these five (5) countries, when summed up to gather, are actually wallowing almost 75%-80% of Malaysia rubber export, only about 20%-25% are being exported to other countries. The total rubber export form 2011, 1212, 2013, 2014 and 2015 were found to be approximately 1,254,000, 1,303,000, 1,349,000, 1,191,000 and 1,113,000 respectively.

Table 1.10: Malaysia's Exports of Natural Rubber by Destinations (MT)

Country	2011 (%)	2012 (%)	2013 (%)	2014 (%)	2014 (%)
China	716,169(57.1)	838,387(64.3)	893,451(66.3)	800566(67.2)	754,640(67.8)
Germany	113,717(9.1)	111,891(8.6)	103759(7.7)	100,774(8.5)	90,135(8.1)
Iran	27,679(2.2)	32,695(2.5)	54,622(4.1)	40,461(3.4)	39,657(3.6)
USA	34360(2.7)	33,200(2.5)	35,612(2.6)	38,754(3.3)	35,729(3.2)
South Korea	43,582(3.5)	31,644(2.4)	25,454(1.9)	18,031(1.5)	13,037(1.2)
Other	318,139(25.4)	255,219(19.7)	235553(17.4)	192,413(16.1)	179,416(16.1)
Total	1,253,646(100)	1,303,029(100)	1,348,451(100)	1,190,999(100)	1,112,614(100)

Source: Department of Statistics Malaysia.

1.7 Problem Statement

The research journey has begun by carefully examining the trends of rubber production in Peninsular Malaysia through plotting of nearly 30 year period of time series data obtained from statistics department of Malaysia. The duration of the time period ranged from year 1982 to 2012 as shown in both the tables 1.2, 1.3 and 1.4 as well as in the diagrams of figures 1.1, 1.2 and 1.3 for rubber planted area, production capacity and productivity(kg/ha)

Comparing the tables and the figures, it would be observed that the values of rubber planted areas, volume of production and productivity yield (kg/ha) of rubber, have not only indicated the exceedingly high percentage of smallholders as compared to estates producers ,but also displayed dwindling , fluctuating and eventually declining movements of the trends. Deductions from such movement specifically showed that, all the 3 parameters -planted area, production capacity and productivity (yield per hectare) of rubber, have an unpredictable scenario and this led us to holistically investigate if the capacity and capabilities of the smallholders, under Malaysian present economic transformation programs, are operating at a level of economic efficiency adequately enough to justify their future strength and survival in the rubber industry in Peninsular Malaysia. In making thorough investigations, this study encompassed problem statements in three folds.

a- The first was to critically look in to the future survival of the smallholders, how technically viable and economically efficient they are? And what is going to be their future strength in the eyes of their competitors in the global market?
b- The second aspect is to examine the perenniality nature of the rubber farms. The current research study was also motivated by the fact that, most of the smallholders' previous studies on technical and economic efficiencies of rubber production were carried out on aggregated data. The aggregation was done on either annual, biennials crops or on perennial whole-age crops, without taking considerations of the perenniality nature of the plantations. The results of these estimates are subject to aggregation bias since perennial crops such as rubber vary in yield according to age of crops. In an attempt to fill in this gap, there is a need to compute and find out if there is any bias or difference between the efficiency scores of aggregated and disaggregated rubber crops ages.
c- The third issue is to vigorously determine the above two concepts using different methodological techniques such as the parametric and non-parametric methods.

However, this study is specifically looking at the following research questions

1- Are the Malaysian rubber stallholders' technical, allocative and economics efficiencies sufficient to guarantee, substantiate and justify their future survivals in the rubber industry?

2- Considering the perenniality nature of rubber crops, which has varying growing pattern throughout its life span, are there any disparities or bias in the technical efficiency scores between aggregated and disaggregated crops ages or the ages of plantations?
3- Are there any impacts or effects (and to what extent?) of different methodological issues or techniques in computing technical efficiency scores of the rubber smallholders?
4- What are the likely factors or determinants influencing rubber smallholders' efficiencies?

1.8 Objectives of the study

The general objective of the study was to analyze the Economic Efficiency of Rubber Smallholders in Negeri Sembilan, Malaysia.

The specific objectives included the following viz:

1. To examine the socio-demographic attributes of rubber smallholders in Negeri Sembilan state according to rubber-age categories.
2. To determine the mean technical and economic efficiency scores of rubber smallholders in Negeri Sembilan using both parametric and non-parametric techniques.
3. To investigate and analyse the presence/absence of aggregation bias in the efficiency scores among the three crops-age categories or between the aggregated and disaggregated age categories of rubber smallholders.
4. To analyse the statistical effects or impacts of the various methodological issues on efficiency scores of the rubber smallholders.
5. To identify and estimate the various factors or determinants militating against technical and economic efficiency scores using Tobit regression analysis.

1.9 Significance of the Study

The Research's significances are in different folds which include the following:

The findings of this study will enable smallholder rubber farmers to gain better and adequate understandings of their levels of technical and economic efficiencies and also the factors determine the efficiencies as this serves as an indicator whether they are progressing or retrogressing economically. Rubber Smallholders will also equip themselves with the knowledge of effective inputs' choices and selections, management decisions especially regarding the age of the plantations as this will enable them to know at what level to inject enough inputs and management skills to improve output and hence profitability and performance.

The government, which is the bed rock and the back born of policy and decision making body, will be supplied with all the necessary and reliable information about economic efficiency and this helps the government in formulating good and workable policies towards economic growth and development.

This study will also contribute to the body of academic literature in some ways. Firstly, it's one of the first empirical applications that carefully looked at the economic efficiencies of perennial trees like rubber in age-wise perspectives.

Secondly, it is also among the pioneers of researches that vigorously and thoroughly utilized virtually all the parametric and non-parametric techniques in analyzing the economic efficiencies.

1.10 Scope of the Study

This study successfully covered only rubber smallholder farms in Negeri Sembilan. Although the study recognized the rubber estate in peninsular Malaysia, but it has not included or conducted any primary findings on rubber estates. It's only covered the rubber smallholder farms. Also independent smallholder farms were not taken in to considerations. Only smallholder farmers which are specifically organized and are under the Supervision of Rubber Industry Smallholders Development Authority (RISDA) were taken into account. The study consist five different districts of rubber smallholders in Negeri Sembilan state of Peninsular Malaysia. These districts include the state capital Seremban, Tampin, Rembau, Kuala Pilah and Jempol districts. Thus, as a result of similar socio-demographic traits, same soil and edaphic characteristics, as well as the same climatic and geographical settings of the smallholder respondents, the research findings can be generalized across the entire Negeri Sembilan state and to some extent the Malaysian peninsular as a whole.

1.11 Organization of the study

The study specifically reported on the various technical and economic efficiencies of rubber smallholders on the basis of age categories of the farms in Negeri Sembilan state of peninsular Malaysia in a well-organized five solid chapters.

Chapter one composed of the introduction and over view of the rubber production in Malaysia and the world in recent years, and this in turn consist of previous rubber yields trends, world natural rubber productions and consumptions for 15 years, number and percentages of smallholders by states as well as the cultivated areas in hectares, Malaysia's natural rubber production in tonnes for several years , quantity and volume of total imports, exports and consumption of natural rubber in Malaysia. Other sub section of the chapter looked at the research's objectives, scope of the study and articulation or organization of the research work.

Chapter two consists of a thorough literature review of empirical studies of various efficiency techniques such as Stochastic Frontier Analysis (SFA), Data Envelopment Analysis (DEA), Free Disposal Hull (FDH), Expected Order-M and Oder-alpha efficiency Analysis. The reviews of literature also constitute the previous empirical works on studies regarding smallholders' technical efficiencies and empirical investigations based on different estimator of efficiency.

Chapter three critically examined the methodology of the study which in turn constitutes the study area, sample procedures, sampling technique, sources of data, pre-testing of questionnaires and analytical techniques used. Also included in the chapter, are methodological issues like statistical models regarding the parametric and non-parametric efficiency techniques. These include stochastic frontier models, consisting of both the Cobb-Douglas and Transcendental logarithmic (Translog) functional forms and their respective technical inefficiency models. Data envelopment analysis (DEA), Free Disposal Hull (FDH), Expected Order-M and Oder-Alpha efficiency Models; Bootstrapped DEA estimation, Determinants of both Technical and Economic efficiencies using Tobit regression models as well as a comprehensive list of the inputs and output used in the research work.

Under the fourth chapter, discussions and presentations of results were fully explained. Such results consist of the socio-economic characteristics of the respondents, regression results of each of the three Age categories of the smallholder respondents, Cobb-Douglas and transcendental logarithmic findings of all the three age categories, Technical Efficiency (TE) of smallholders under both the Variance Return to Scale (VRS) and Constant Return to Scale (CRS) assumptions, Bootstrapped and bias-corrected TE scores, Free Disposal Hull efficiency scores, Expected Order-M and Order –alpha efficiency scores of each of the 3 age categories of the smallholders. The chapter also captured various paired means test for comparison among the age-category or group of the smallholders on the basis of both VRS and CRS assumptions, on the basis of both Cobb-Douglas and Translog functional forms, on the basis of naïve DEA and Bootstrapped DEA and on the basis of FDH, Expected Oder-M and Order-Alpha Efficiency Techniques. Determinants of TE and EE were also discussed under this chapter.

Chapter five will cover the summary of the study and recommendations. The theoretical and empirical implications with limitations and drawbacks of the study were also discussed.

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