UNIVERSITI PUTRA MALAYSIA

PERCEIVED IMPACT OF KAMPUNG TEKNOLOGI RISDA PROGRAM ON RUBBER SMALLHOLDERS IN MALAYSIA

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By

SHAKIR MAHMOOD JAAFAR AL-AWQATI

Thesis Submitted to the School of Graduates Studies, Universiti Putra Malaysia, in fulfillments of the Requirements for the Degree of Master of Science

June 2018

DEDICATION

To my father and father in-law… God bless their souls

To my mother… God bless her

To my wife Ameena for her endless love, care, support and perseverance

To my mother in-law for her care and encouragement

To my wonderful children Nawwara, Rend and Mahmood for their patience and inspiration

I dedicate this work with affection.

Shakir

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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June 2018

Chairman : Associate Professor Norsida Man, PhD
Faculty : Agriculture

Currently, Malaysia is the world's sixth largest producer of natural rubber (NR). To preserve sustainable occupation, National Agriculture Polices (NAP), government integration, with related agencies are targeting the employment of contemporary agricultural methods to increase NR production and livelihood of rubber smallholders, whom are the predominant contributors of NR production. Kampung Teknologi RISDA (KTR) program was implemented for this purpose by Rubber Industry Smallholders Development Authority (RISDA). The KTR respondents' perception towards KTR program, KTR's technology and extension activities were seen significant contributors to their perceived impact (outcome) of KTR program. Thus, to affirm the achievement of the stated goals an outcome program evaluation would be a sound procedure to explain KTR's effectiveness extent on KTRs' rubber respondents' wellbeing.

Owing to this, the study objectives are to: 1) identify the respondents' perception level towards: KTR program, KTR's technology and extension activities; 2) determine the respondents' perceived impact level towards KTR program; 3) identify evidence of change (outcomes) related to KTR program impact; 4) identify the relationships between the respondents' perception levels towards: KTR program, KTR's technology and extension activities and the perceived impact; 5) identify the influences and relationships between selected socio-demographic factors, perception towards KTR program, perception towards KTR's technology and perception towards extension activities and the respondents' perceived impact of KTR program.

Being quantitative and descriptive, the research's questionnaire survey encompassed the states of Perak, Pahang, Selangor and Negeri Sembilan four (4) central states of Peninsular Malaysia, targeting 341 respondents among KTR participants. Owing to the geographical distribution, stratified sampling was involved to maintain subgroups' characteristics and assert equal representation. The logic model as the evaluation tool, supported the independent and dependent variables selection. Applications of SPSS ver.22 and Microsoft Office 2013, Excel were involved to conclude further statistical results.

The results showed that the majority of respondents (76.3%) were more than 51 years of age, where 59.8% were males and 40.2% were females. Furthermore, the study recorded that KTR respondents have a high perception levels towards KTR program, technology and extension activities, with total average means of (4.06), (3.92) and (4.1), respectively, which are substantial sings towards adoption. Whereas, the perceived KTR impact recorded moderate level with an overall average mean of (3.44).

Correlations between perceptions towards KTR program, KTR's technology and extension activities and perceived KTR impact were positive and significant. Finally, the Logistic regression results showed, that nearly all independent variables were positive and significant. However, level of education recorded negative and significant, and type of farming system was positive but non-significant to the perceived impact.

To conclude, the respondent's determination to embrace the new technology and adopting it was evident. In addition, to the program positive impact. Yet, they are advancing in age with income and level of education among other factors are contributors the program's rapid outcomes. Therefore, further plans are required to support and increase their income, assessing such factors influencing the program's goals achievements and to carry out more research to identify the absence of the young generation and for solutions to preserve the continuity of the industry.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

KESAN KAMPUNG TEKNOLOGI RISDA (KTR) TERHADAP PEKEBUN KECIL GETAH DI MALAYSIA

Oleh

SHAKIR MAHMOOD JAAFAR AL-AWQATI

Jun 2018

Pengerusi : Profesor Madya Norsida Man, PhD
Fakulti : Pertanian

Pada masa ini, Malaysia merupakan pengeluar getah asli keenam terbesar di dunia. Bagi memelihara bidang pekerjaan ini, melalui Polisi Pertanian Negara (NAP), pihak kerajaan bersama dengan agensi yang berkaitan mensasarkan penggunaan kaedah pertanian kontemporari untuk meningkatkan pengeluaran getah asli dan juga meningkatkan taraf hidup pekebun kecil, dimana mereka merupakan penyumbang utama pengeluaran getah. Program Kampung Teknologi RISDA (KTR) telah dilaksanakan bagi tujuan ini oleh Lembaga Kemajuan Pekebun Kecil Perusahaan Getah (RISDA), dengan matlamat yang telah ditetapkan serta menambah satu jenis penilaian program yang baru. Oleh itu, satu penilaian hasil diperlukan untuk menjelaskan keberkesanan KTR dan sejauh mana kesannya terhadap keadaan kesejahteraan pekebun kecil getah.

Oleh itu, tujuan kajian adalah untuk: 1) menentukan tahap persepsi responden terhadap program KTR, teknologi KTR dan aktiviti pengembangan; 2) menentukan tahap impak responden terhadap program KTR; 3) mengenalpasti bukti perubahan (hasil) yang berkaitan dengan kesan program KTR; 4) mengenal pasti hubungan antara tahap persepsi responden ke arah: program KTR, teknologi KTR dan aktiviti pengembangan dan keberkesanannya; 5) mengenal pasti pengaruh dan hubungan antara faktor sosio-demografi terpilih, persepsi terhadap program KTR, persepsi terhadap teknologi KTR dan persepsi terhadap aktiviti pengembangan dan tahap persepsi responden terhadap impak KTR.

Dari segi kuantitatif dan deskriptif, kajian penyelidikan ini merangkumi empat (4) negeri di Semenanjung Malaysia iaitu Perak, Pahang, Selangor dan Negeri Sembilan, yang menyasarkan 341 responden di kalangan peserta KTR. Bagi pembahagian sampel, pensampelan berstrata digunakan bagi mengekalkan ciri-ciri subkelompok dan merangkumi perwakilan yang sama. Model logik digunakan sebagai alat penilaian, menyokong pemilihan pembolehubah terkawal dan bebas. Aplikasi SPSS ver.22 dan Microsoft Office 2013, Excel terlibat untuk mendapatkan keputusan data statistic.

Keputusan menunjukkan bahawa majoriti responden (76.3%) berumur lebih daripada 51 tahun, dimana 59.8% daripadanya adalah lelaki dan 40.2% responden adalah perempuan. Selain itu, kajian ini mencatatkan bahawa responden KTR mempunyai tahap persepsi yang tinggi terhadap program KTR, teknologi dan aktiviti pengembangan, dengan masing-masing mendapat jumlah purata (4.06), (3.92) dan (4.1). Selain itu, keputusan yang direkodkan menunjukkan bahawa kesan KTR adalah sederhana dengan purata keseluruhan (3.44).

Korelasi antara persepsi terhadap program KTR, teknologi KTR, aktiviti pengembangan dan impak KTR yang dilihat adalah positif dan penting. Analisis regresi logistik menunjukkan bahawa semua pembolehubah bebas adalah positif dan signifikan, manakala tahap pendidikan mencatatkan negatif dan signifikan dan jenis sistem pertanian didapati positif dan secara signifikan memberi kesan yang tinggi daripada program (.05). Hanya pendapatan yang didapati negatif dan signifikan pada tahap (.01), manakala saiz ladang adalah positif tetapi tidak signifikan kepada kesan KTR.

Sebagai kesimpulan, program tersebut memberi kesan kepada responden dengan hasil yang menunjukkan responden mempunyai keinginan untuk menerima teknologi baru. Tambahan pula, usia responden yang agak berusia dengan pendapatan dan tahap pendidikan merupakan antara faktor lain yang penyumbang kepada hasil program yang baik. Oleh itu, rancangan selanjutnya diperlukan untuk menyokong dan meningkatkan pendapatan mereka, penilaian faktor-faktor yang mempengaruhi pencapaian matlamat program dan menjalankan penyelidikan yang lebih banyak untuk mengenal pasti ketiadaan generasi muda dan penyelesaian untuk memelihara kesinambungan industri.

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Deep gratitude and appreciation goes to my family for bearing life difficulties alone and waiting for me all these long months.

To my wife, I am who I am because of you and did not reach this far without you.

I certify that a Thesis Examination Committee has met on 27 June 2018 to conduct the final examination of Shakir Mahmood Jaafar Al-Awqati on his thesis entitled "Perceived Impact of Kampung Teknologi Risda Program on Rubber Smallholders in 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 Master of Science.

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I hereby confirm that:

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This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
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Name of Chairman of Supervisory Committee: Associate Professor Dr. Norsida Man

Signature: _____
Name of Member of Supervisory Committee: Associate Professor Dr. Nolila Mohd Nawi

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LIST OF ABBREVIATIONS

%	Percent
´E	East
´N	North
°C	Degrees Celsius
°N	Degrees North
°S	Degrees South
ALDP	Agriculture Land Development Program
BMP	Best Management Practices
CCI	Comprehensive Community Initiative
CIPP	Context/Input/Process/Product
CODAPEC	Cocoa Pest and Disease Control
DOA	Department of Agriculture
DV	Dependent Variable
ECB	Evaluation Capacity Building
EPP	Entry Point Projects
ESS	Ecosystem Services
ETP	Economic Transformation Program
FAMA	Federal Agricultural Marketing Authority
FAO	Food and Agriculture Organization
FELCRA	Federal Land Consolidation and Rehabilitation Authority
FELDA	Federal Land Development Authority
FFS	Farmer Field Schools
GAP	Good Agricultural Practices
GPRA	Government Performance and Results Act

ha	Hectare
ICT	Information And Communication Technologies
IFS	Integrated Farming Systems
IPM	Integrated Pest Management
IRM	Imazapyr-Resistant Maize
IV	Independent Variable
JPS	Jabatan Pertanian Sarawak
KASA	Knowledge, Attitude, Skill and Aspiration
KTR	Kampung Teknologi RISDA
LIGS	Lembaga Industri Getah Sabah
LITS	Low Intensity Tapping System
LKIM	Malaysia Authority Fisheries Development
LM3	Local Multiplier 3
MARDEC	Malaysian Rubber Development Corporation
MARDI	Malaysian Agricultural Research and Development Institute
MDP	Malaysian Development Plan
MPIC	Ministry of Plantation Industry and Commodity
MRB	Malaysian Rubber Board
MRELB	Malaysian Rubber Exchange and Licensing Board
MRRDB	Malaysian Rubber Research and Development Board
NAP	National Agricultural Policy
NKEA	National Key Economic Areas
NR	Natural Rubber
PBRN	Practice-Based Research Network
PT	Program Theory

PTE	Program Theory Evaluation
R&D	Research and Development
RISDA	Rubber Industry Smallholders Developing Authority
RM	Malaysian Ringgit
RRIM	Rubber Research Institute Of Malaysia
SAP	Sustainable Agricultural Practices
SHAS	Smallholders Advisory Service
SIP	Sustainable Intensification Practices
SMR20	Standard Malaysian Rubber 20
SPSS	Statistical Package for Social Sciences
SSA	South Saharan Africa
TOT	Transfer of Technology
UWEX	University Wisconsin-Extension
VIAT	Volunteering Impact Assessment Toolkit

CHAPTER 1

INTRODUCTION

The background of the study and the Natural Rubber (NR) industry will be exemplified in this chapter, highlighting the involvement of the government, integration, implementing agencies and parties and their respective clients, who are the NR producers. The statement of the research problem, research questions and the objectives of the study are also included in this chapter.

1.1 Agriculture in Malaysia

The agricultural sector in Malaysia has been one of the main contributors to the economy and has continued to do so because, in addition to the contribution to the economy which is at about 9.4%, it is an employer of 14.8 million of the Malaysian population. Among the major employers of labor in agricultural sector of Malaysia is the NR industry and the output of their production has placed the country to be one of the top NR producing countries in the world (Fox and Castella, 2013) .

The agricultural sector of Malaysia immensely benefited from the British establishment of large scale plantations of commercial crops, including NR in 1879, palm oil in 1917 and cocoa in 1950. These crops have remained dominant in the exports of agricultural products of the country. Malaysia's tropical climate supports the production of exotic fruits and vegetables that are mainly servicing the local demands and even beyond (Firuza, 2011). These include fruits like banana, coconut, durian, pineapples among others. The coastal regions provide enough fisheries, forestry and livestock production which are seen to be excellent contributors to the socio-economic development and national food security.

Although the country is rapidly evolving to becoming an industrialized nation, agriculture remains very important and as such the country is viewed as an agricultural country. This is obvious when one considers the percentage of land and population engaged in agricultural activities. It is reported that in the year 2013, agricultural sector was reported to have provided employment to about 10.9%, 23% contribution to the total export earnings and has added 7.2% of the general domestic product (Dardak, 2015). Drawing upon the government policies and strategies to develop the sectors, the projection presents a depiction of eras that were classified as having distinguished policies and approaches to achieve advancement in the sector, thus agriculture in Malaysia could be divided into two (2) segments, the pre-Independence era and the post-independence era (Dardak, 2015; Matahir and Tuyon, 2013).

1.1.1 The Pre-Independence (1948-1957)

As mainly all pre-independence agricultural policies in British colonies were to serve the interest of the British nation, the main agricultural policies of the era thus were characterized by the production of commodities that serve the interest of the colonial masters. NR and spices were the main interest at that time and thus there were the plantations that produce to serve the industries of the United Kingdom (UK) and by extension the United States of America (USA). During that era, NR was the most important contributor to the economy, while other crops, fruits and vegetables were also produced by the smallholder farmers, but the consumption was mainly local. The policies raked in foreign exchange to the country, while also leading to the establishment of Malaysian infrastructures like the rails, roads and ports, which were used to haulage the agricultural produce. This created some additional employment and opportunities for the development of the country. Although local Malaysians were involved in the production of agricultural produces, but it was restricted to the small commodities that were not commercially viable and for local consumption. The British reserved the right to produce NR and export to themselves during this epoch. Hence, entry was especially restricted to the colonials.

1.1.2 Post-Independence (1957-2020)

This era has four (4) more segments identified. These were:

1) Agrarian Based Economy Era

This era was characterized by the agricultural derive economy. The period spanned from 1957 through to 1985 and was detailed by the 1st to the 4th Malaysian Development Plans (MDP). In this era, agriculture was acknowledged as the main source of income and therefore contributed to social development. It was seen to have lifted the livelihood of the poor and provided the industries with the raw materials for industrial and economic development. It was estimated that the public and individual effort was able to make the agricultural sector grow on an average of 4.88% annually, between the years of 1960-1965. Furthermore, through 1957-1983 the government policy "the Malaya economic plan" was to preserve the British plan of exporting the industrial crops to the industries of the west. Consequently, it has thrived the Malaysian economy through the generation of foreign exchange income, employment for locals and the generation of capital.

2) Industrialization of the Economic Era

This era was from 1986-2000, which was spelt out in the 5th, 6th and 7th MDPs and the emergence of the first National Agricultural Policy (NAP1) from 1984-1991. In tandem with the ideas of globalization and economic diversification, the policies see the diversifying away from agriculture as a panacea to development. This is because the single or limiting to agricultural sector is seen to require a broader base to sustain

it. It therefore promotes industrialization and manufacturing. This relegated the agricultural sector and promoted the manufacturing sector. Hence, they were to contribute majorly to the economy. However, because of the Financial Crisis of the Asian nations in the 1997 and 1998, the agricultural sector started to garner some level of attention in the country. NAP1 was to promote an effective long term policy for an effective agricultural sector development and contribute to the alleviation of poverty of the smallholder farmers, increase the export commodities value for export, land competition by other sectors and labor shortage. The second agricultural policy NAP2, 1992-2010, was further developed to complement the NAP1.

3) Broad based Economy Era

This era was from 2001-2010 with the 8th MDP and 9th MDP and NAP2 and NAP3 as anchors. The NAP2 and NAP3 empowered the government impetus to achieve higher production rates in a sustainable manner. The natural resources were conserved, utilized and thus promoted commercialization and creating higher opportunities to farmers for higher income generation. There was a rebranding of the sector to focus on the commercializing of agriculture into 'agribusiness', which encouraged the engagement of big players both locally and internationally. The NAP3 promoted the mechanization of the sector and thus displacing the human labor while promising higher output and efficiency. The mechanization resulted in higher productivity and with a lesser cost of production.

4) New Economic Model Era

An era that commenced in 2011 and will last till 2020, aided by the introduction of the National Agro-food Policy NAP4 2011-2020 which is spelt out in the 10th MDP that promised the development in a sustainable fashion. That is, it is an era where developmental efforts are consciously and intensively geared towards conserving the environment. The era presents economic transformation program (ETP) with which there were 12 identified vital National Key Economic Areas (NKEA), within which agriculture sector being one of the mentioned areas that will be transformed by 2020 to agribusiness and would be responsible for the expected high growth in the agricultural sub-areas of aquaculture, food processing, fruits and vegetable products, marine and livestock products, paddy, among other products. Figure 1.1 displays all National plans and policies from 1957-2020.

<table>
<tr><td rowspan="6">The Malaya Economic Plan 1957 - 1983</td><td>First Malaya Plan</td><td>1956-1960</td><td></td><td></td></tr>
<tr><td>Second Malaya Plan</td><td>1961-1965</td><td></td><td></td></tr>
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</table>

Figure 1.1 : Government Plans and Policies since Independence
(Source : Dardak, 2015; Matahir and Tuyon, 2013)

1.2 Natural Rubber Industry in Malaysia

The few rubber tree seeds that survived the nineteenth century expedition from the rainforest of Brazil through the botanical gardens of England and finally Malaysia, were to multiply and to make Malaysia one of the largest producers of NR. Malaysian NR industry has grown and become the fourth ranking in terms of production (Goldthorpe, 2015). This enviable position and many prospects in agriculture have made the country refocus its attention on agriculture for the sustenance of the ranks in plantations of palm oil, NR and cocoa. The new Malaysian economic development plan includes the goal of repositioning the agricultural sector to be the third engine of national growth, after manufacturing and services that are the main contributors to the economy.

The focus is mainly on the advancement of industrial crops; this is partly due to the fact that about 80% of the 406 million hectares of farmlands are planted with these crops (Matahir and Tuyon, 2013). This clearly means a deliberate and conscious effort to develop the capacity of farmers and other agricultural livelihoods with knowledge and appropriate technologies to achieve this aim. Hence, the introduction of RISDA and similar organizations with a sole aim of supporting the large scale production of the industrial crops thereby, repositioning the agricultural sector to be one of the main contributors of the economy.

1.2.1 Natural Rubber

Christopher Columbus discovered the natives of Haiti in the 1493 playing ball made from NR. This was the first reported history of NR. The name rubber was first ascribed to the latex in the late eighteenth century when Joseph Priestly discovered its ability to erase inscription made from graphite marks or pencil much better than the convention of using bread crumbs (Giersch and Kubisch, 1995). The present century witnessed high utility of the NR when Europeans found it quite useful in making "Mackintoshes" (waterproof raincoats). But, it was in the 1839 that the concept of vulcanization was discovered by Charles Goodyear. This was when he discovered that adding Sulphur to NR improved its properties greatly (Liu, Mead and Stacer, 1998). This heralded the beginning of the NR industry. The nineteenth century brought out the prelude of advanced practices and machinery to produce rubber goods, which induced commercial trading in NR and cultivation.

In 1910, there was the NR boom in Southeast Asia, which created an enormous surge to plant the crop on greater scale. Owing to this, within 4 decades, this crop was converted from an undomesticated tree of the jungle to a large-scale domestic crop. More into this, coming to the end of the nineteenth century, the accelerated evolution in transportation i.e. railways and steam-ships, in addition to Suez Canal opening, contributed to Southeast Asia plantations to thrive. This resulted from the extended market demands for NR as being a vital element in manufacturing a wide range of finished products pouring into every aspect of the growing diverse industry (Nair, 2010).

1.2.2 Climatic Requirements of Natural Rubber

Typically, for most cash industrial crops like oil palm, cocoa and coffee, NR also thrives better in a climatic condition that is characterized by high rainfall and low elevation. This describes the tropical moist rainforests (Phommexay, Satasook, Bates, Pearch and Bumrungsri, 2011). Usually found in the between 25° North and 21° South, within which these countries are located: China, Indonesia, Malaysia, Papua, New Guinea, Cambodia, Sri Lanka, Thailand, South India and Philippines in Asia. In addition, part of Africa which comprises of Congo, Cameroon, Ivory Coast, Liberia and Nigeria with the tropical America and Brazil. These countries are known to support production of NR and other plantations due to their climatic conditions which favour their production. Optimally, the production of rubber trees is obtained when they are grown between the 15°N and 10°S and a stable temperature that ranges between 24-26°C with a humid condition that is between 60-80% all around the year (Verheye, 2010).

The location should also be of low altitude, 700-800m maximum, at the equator, which is also known to favour distribution of high annual precipitation of about 1,800 and 2,500mm. Usually, the off peak is for just a period of 2-3 months which is also necessary for the process of defoliation and solar radiation to prevail, with the intensity

ranging between 1,500-1,800 hours per annum. The trees can endure 5-6 months of drought, provided there is some moisture in the soil. The most suitable soil type for the growth of rubber trees is deep soils with 2m minimum, fertile well aerated and well drained soils with a pH 4.5-6. Nevertheless, the trees can be grown on other wide-ranging soil types; however sloppy soils are poor supporters of NR production, mainly due to possible erosion and inability to hold moisture and towards tappers and maintenance (Verheye, 2010).

The *Hevea* variety, which is the traditional most commonly grown rubber tree in South East Asia, demands 2,000 sunshine hours per year, a mean temperature of 28ºC high and ± 2ºC low and annual rainfall of 2,000–4,000mm. Moreover, some Chinese clonal varieties are able to withstand the long dry conditions with a less intensity of sunshine and lower temperatures which can go as low as –1ºC, in addition to a latitudes of 22ºN and higher altitudes of more than 900m. They can also thrive well and withstand low fertile soils and other pressures of climatic conditions (Warren-Thomas, Dolman and Edwards, 2015).

1.2.3 History of Natural Rubber Production in Malaysia

The adventure and expedition of Sir Henry Wickham in 1876 benefited the British with a thriving plantation on a land that NR was never cultivated. This brought a lot of economic benefit as the flourishing tyre industry was demanding the NR exponentially which the plantations became a respite and convenient source. He was known to have collected 70,000 rubber trees seeds (Para-rubber tree), *Hevea brasiliensis*, from Tapajos river basin in Pará, Brazil. He ferried them in a boat to London for germination in Kew in Royal Botanical Garden, although somehow out of the 70,000 only 4,000 seedlings reached London; the remainder got dispersed around the world and some perished. Within them, there were about 20 seedlings that survived and got freighted to Malaysia and Ceylon (Sri Lanka) and they were to become the derivatives of the rubber trees that populate the forests and plantations of these countries (de Souza et al., 2015).

The freighted seedlings of rubber found their way into Malaysia (Perak and Malacca) while some were freighted to Singapore Botanic Gardens. The director and Botanist Sir Henry Nicholas Ridley (mad Ridley 1855-1956) succeeded in propagating the remaining seedlings which originated 75% of all current rubber trees. He succeeded in determining the plantation density, method of incision and even most suitable area for production; as thus he is known as the father of NR industry in the Southeast of Asia. He was the major campaigner for the production of the unpopular crop which was not favoured by the producers but rather they prefer tapioca, pepper etc. Sir Ridley, was able to convince Malay planters of the merit of the crop, its commercial viability and even invented the basis of present-day tapping (harvesting method) technique (Chan, Joy, Maria and Thomas, 2013).

By the early decades of the 20th century, there was an expeditious and spatial diffusion of *Hevea* plants which is seen as of the success of the Western colonial enterprise. There was a vast and large return to investment that resulted from NR export, that it became one of the main economic pillars of the country. It provided employment and livelihood for a significant number of the populace (Goldthorpe, 2015).

1.2.4 Natural Rubber Industries Evolution in Malaysia

The Southeast Asia is the prime source of all NR in the world and it is known to produce about 97% of the world production. Malaysia is rated third following Thailand and Indonesia. Thailand is contributing 31% of the world production of NR, while Indonesia is producing 30% and Malaysia is producing 9% (Fox and Castella, 2013). It was reported that 92% of the NR in the world comes from Southeast Asia and about 6% from Africa while the Latin America produces 2% of the world's NR production (Venkatachalam, Geetha, Sangeetha and Thulaseedharan, 2013). Ever since the first contact with rubber in 1877, Malaysia has witnessed the growth of the rubber plantation venture and became a significant world producer.

The first rubber plantation was established in 1890 and since then the growth and establishment of the plantation kept increasing so much that the World Bank reported by 1955 that cultivated land of Malaysia was covered by *Hevea*, to about 65%. Consequently, it became the world's largest denominator of NR production through 1900-1991(Goldthorpe, 2015; Verheye, 2010). By the end of the year 2004 there were a total of 6.4 million hectares that were used for agriculture and within which 60.6% was for oil palm and 20% was for rubber. Table 1.1 reveals a shrinkage in the area of total acreage of rubber plantation to -2.54% in the period 1990 to 2004 whereas oil palm expanded at an average rate of 4.7% per annum (Razak, Aziz, Ali, Ali and Visser, 2016). They also revealed, the inconsistencies and fluctuations in the production of NR and the causes are apportioned on the issues of unstable price of NR, negative weather conditions and shortage of labor; this is in addition to the exodus of the producers to the oil palm industries. More into this, recent figures showed, this position is still falling back to be sixth in 2016 among NR producing countries (FAO, 2018) with total production of 673.5 metric tons.

Table 1.1 : Natural Rubber Production and Rubber Planted Area between 2011 and 2015

Item	2011	2012	2013	2014	2015
NR Production (Metric Tons)	996.2	922.8	824.6	668.6	722.1
Rubber Planted Area (000 Hectares)	1,012.8	1,059.7	825.0	827.7	824.4

(Source : Annual NR Statistics 2016, Department of Statistics, Malaysia)

1.3 Rubber Industry Smallholders Developing Authority (RISDA)

The establishment of the Malaysia's NR industry was in 1876 by the British introduction of the rubber tree in Malaya. Since then, there has been a great deal of researches that are being conducted by universities, institutions and organizations, which are all aimed to make it a sustainable and productive industry. Studies are done in both the upstream and downstream sectors. Within the leading institutions for NR research and advisory services is the Rubber Research Institute of Malaysia (RRIM) which exhaled and was reputed as the leading NR research institution in Malaysia. This organization was to be repositioned in both operation and identity in the year 1998 and it was thus deemed that the organization be rebranded by combining it with other NR agencies that were operating in isolation. This is to have a coordinated and better operation in the sector and it was eventually renamed as the Malaysian Rubber Board (MRB). This is to become the pioneer board ever and it was saddled as the custodian board for all NR industries activities and was operated under the supervision of the Ministry of Plantation Industry and Commodity (MPIC) (Hazir and Muda, 2016).

Hitherto, the service to NR producers was mainly by different organizations that were independently operating. For example, the period of 1934 till 1972, extension education and services were rendered by the Smallholders Advisory Service Division (SHAS) of (RRIM) throughout the country. The organization became responsible for all trainings that were given to the professionals and paraprofessionals that were operating in the various smallholder sector of NR production, which was done mainly in both pre-service and in service level. With the change, the divisions were split and replaced by two (2) new divisions namely, the Smallholders Project Research Division and Training Division and the formation of RISDA in 1973, which were to be responsible for implementation of any large-scale research innovations in smallholdings. The Training Division became responsible for the training of all aspects and levels of training that aims at providing the needed skilled personnel required by the Malaysian NR industry, be it a smallholder, field manager, supervisory extension worker or marketing officer (Abdullah, 1977).

Thus, this agency that was originally established to administer the replanting program in the 1950s later was to became public and named as Rubber Industry Smallholder Development Authority (RISDA) (Bissonnette and De Koninck, 2015). Its operations became effective on the 1st of January, 1973 as a result of the enactment of the Rubber Industry Smallholders Development Authority Act, 1972 under Malaysian Law (No. 85) (Abdullah, 1977). RISDA has since been responsible for the replanting and new planting of the smallholders sector with modern high-yielding planting materials and it ensures the revolutionizing of the smallholder sector to a modernized ventured that would ensure the improvement of the welfare of small scale rubber producers.

It was saddled with the responsibilities of improving and extending smallholdings inputs, provide replanting funds to smallholders, provide subsidies and manage basic infrastructures and processing crop just like the Federal Land Consolidation and Rehabilitation Authority (FELCRA)**.** RISDA is also to provide social development activities through its Smallholders Development Centres (Vermeulen and Goad, 2006). In Malaysia, there are two (2) organizations that are charged with the primary responsibility of increasing rural income which are FELCRA and RISDA. The two organizations charged with the responsibilities of increasing the welfare as well as the productivity of already existing agricultural areas (Aslam and Hassan, 2003). Conversely, the specific roles and expectations of these two (2) organizations differ in coverage and operations.

1.3.1 Objectives and Roles of RISDA

The primary objective of establishing RISDA is to ensure that the rubber smallholders' productivity and efficiency are raised. This is to be achieved through the replanting of hybrid rubber trees, new technologies exercise and access to advisory services for good and best agricultural practices. Additionally, RISDA is having amongst its goals to create and nurture a more forward looking and modern generation of farmers that would outstand all competition and meet the current demand for commercialization and therefore contribute to agricultural and industrial development (Bissonnette and De Koninck, 2015). Therefore, it is an organization that hopes to increase the productivity of the smallholder producers through the provision and linkage to subsidies sources, better improved hybrid seedling of rubber trees and developed facilities of processing and marketing of the products (Aslam and Hassan, 2003).

It is therefore among the RISDA duties and responsibilities to carry out the administrative actions in the NR industry; the planning and implementation of all research innovations in the smallholder sector; implement all agricultural innovations that emanate from research; co-operate and liaise with all other national agencies responsible for research, extension, provision of agricultural credits, processing and marketing of NR and effect expeditiously the modernization of the smallholder sector; carry out the replanting and new planting of the smallholder systematic manner; ensure that the smallholder sector is modernized in every sense to improve the economic well-being of the smallholders and obtain and keep the necessary statistics relating to the smallholder sector and cause such information to be available to the Government.

1.3.2 Programs and Activities of RISDA

RISDA is the organization that is solely responsible for the central role of overseeing rubber smallholdings' development and it is the singular instrument that is aiming to pursue as stipulated in the 9th Malaysia Plan 2006-2010. The approach is to disseminate vital and important innovations and diffusion of new high-yielding varieties for replanting and new planting (Bissonnette and De Koninck, 2015; Mustapha, 2011). It is therefore aimed to modernize the smallholder NR producers

operations in all ramifications. It also seeks to ensure the implementation of researches findings from institutes and universities in the aspects of replanting, use of better yielding seed, harvesting and processing of the NR up to the marketing of these products.

The practice of RISDA is the implementation of concepts and practices in an integrated approach in the entire attempt to solve problems affecting the rubber smallholder sector and the development of programmes to improve their economic well-being. This is mainly done in an operational approach based on four (4) factors of production that is availability of land, labor, capital and management. Smallholders are usually equipped with land and labor and this is where RISDA provides assistance in the form of both grants as well as material and advisory services to assist smallholder entrepreneurs. Effective combination and application of these four (4) factors of production are important in order to achieve higher levels of productivity and efficiency.

RISDA's in this field is to ensure that assistance is provided to smallholders and fully utilized and make efficient use of their production assets (Abdullah, 1977). In addition to this, it implements various activities which include replanting of existing plantation, establishment of new plantations to be developed for the benefits of the smallholders, developing and supplying planting materials and providing linkages services by which they can be made available to the smallholders, obtaining statistics of their activities both output and impact, carrying out project evaluation and improving the marketing system for rubber smallholders. All these activities are targeted towards the improvement of the social and economic well-being of the smallholders. RISDA has also been charged to expand the replanting activities in the estate sector which was hitherto carried out by a separate organization.

In partnership, the government has used its agencies like RISDA, Lembaga Industri Getah Sabah (LIGS), Department of Agriculture Sarawak, Federal Land Development Authority (FELDA) and FELCRA to promote the replanting and new planting exercise to bridge the disenchantment that NR production suffers. The efforts seek the granting of funding for production that ranges from RM 9,000 to RM 14,000 per hectare to ensure the revitalization and sustenance of the NR industry and of small farmers in the country.

In this vein, the government has allocated a lot of funds for the replanting operations. For example, the year 2015 witnessed a budgetary allowance of RM 96.71 million dedicated to replanting and RM 110.08 for new establishment of plantation nationwide. It is protected that the budget is sufficient enough to facilitate and support a targeted 24,000 hectares of replanting and new establishment. This is to be implemented by appointed Implementation agencies which involved RISDA, LIGS and Jabatan Pertanian Sarawak (JPS). In Peninsular, RISDA will be solely responsible for replanting and new plantations. LIGS will be responsible for both replanting and new planting in Sabah. While in Sarawak, JPS will be involved in new planting while

RISDA in replanting. Resulting from the recent injection of RM 100 million by the government as an incentive to the falling prices of commodities, more replanting is expected. From the 1st January 2015, all smallholders that could not make above RM 4.60 per kilogramme from Standard Malaysian Rubber 20 (SMR20) would benefit from this incentive. An addition of RM 206.8 million was also allocated for replanting and new planting activities nationwide in 2015 (Economic Transformation Programme Annual Report 2014, 2015).

These agencies, apart from ensuring and promoting planting and replanting, there are also involvements in the provision of marketing linkages and processing to guarantee a stable and appropriate cost affecting the producers. The agencies like RISDA, Malaysian Rubber Development Corporation (MARDEC), Federal Agricultural Marketing Authority (FAMA) and Malaysia Authority Fisheries Development (LKIM) are very much involved in (Aslam and Hassan, 2003). MRB is another agency that is also regarded as one of the custodian of the NR industry in Malaysia. It was established on 1st January 1998 resulting from the merger of three (3) organizations that were all serving the NR industry. They are the Rubber Research Institute of Malaysia (RRIM), the Malaysian Rubber Research and Development Board (MRRDB) and the Malaysian Rubber Exchange and Licensing Board (MRELB).

MRB is domiciled as a government agency under the MPIC. The chief objective of the MRB is to promote and ensure the development of the sector. It is to ensure the revolutionizing of the industry to meet the modern and global best practice in the Malaysian NR industry in all aspects of the process, from cultivation of the rubber tree, the extraction and processing of its raw NR, the manufacture of rubber goods and the marketing of NR and rubber product. MRB as a custodian of NR industry and research, organizations have since taken the vital step to transfer its technologies to the implementation agencies such as RISDA and the smallholders.

Transfer of Technology (TOT) is an important function of MRB, where Research and Development (R&D) findings are promptly disseminated to the industry for adoption. New technologies in the NR industries evolved from time to time as deliverables from R&D. Relevant technologies with specific objectives and output need to be transferred to the end users. The efforts are aimed at improving the socio-economic well-being of the smallholders, especially to improve productivity and to increase incomes of the smallholders (Nalini, Izah, Malik and Musa, 2014).

The mission of TOT programme is to enhance the productivity of NR, so as to improve the socio economic well-being of rubber smallholders' producers, through effective use of NR improved technologies. As it was asserted by Swanson (2010), TOT is a process of disseminating new technologies and other practical applications that largely result from R&D efforts in different fields of agriculture. The instruments that were deployed by the Malaysian government to achieve this were the implementing agencies that are saddled with the task and they include MRB and its implementing

agencies such as RISDA, FELDA and FELCRA to ensure an effective and productive dissemination of new technologies with less problem and higher adoption rate.

Various approaches were deployed by these organizations to transfer new technologies derived from R&D to the industry. The MRB does that through its publications and the electronic media, regularly publicizing its technologies and findings to create awareness to the public, particularly the rubber smallholders. Also, there are interactive activities like workshops, seminars and colloquia that are most often held to keep stakeholders abreast of research findings and/or specific target audiences. Special attention was given to the smallholders, therefore the ensuring of good interpretation and use of efficient channel for achieving and understanding of maximizing the rate of transfer and adoption (Nalini et al., 2014).

1.4 Rubber Smallholders

In Malaysia, prior the Second World War, the NR industry was mainly to serve the Britons and their colonies. Policies were strongly directed to encourage the production of the commercial crops, which was mostly done in British owned plantations. The fact that the venture of NR production has proven to be a profitable and practicable crop, made them to source for the extra needed labor at that time. This resulted in the bringing more people in their plantations. Then, both Malays and the Chinese were domiciled in the farms in addition to the Indians that were mainly the labor for these ventures.

Consequently, the involvement of the locals was followed by an encouragement by the British colonial government for smallholders' agriculture to boost economic wellbeing and the generation of a source of permanent wealth. Accordingly, small bits of land were designated to those settlers to establish what is called Kampung (homestead) which were aimed to improve production. Those variant areas of Kampungs were producing in a mixed culture system of farming, where they produce other horticultural produce with commercial crops which are mainly farmed in the settlers' homes (Voon, 1995). It was asserted that, those peasants' or smallholders' production are extensively accounted for food security, rural subsistence and country's economy (Altieri, Funes-Monzote and Petersen, 2012).

To define those farmers, scholars viewed smallholders in terms of their land holdings, that is, the hectare may slightly be different. An example is where smallholders are viewed not to have less than two (2) hectares but owning up to four (4) hectares (Azhar et al., 2013). So the need for a clear statement of the intended researcher definition of smallholders in the context of the research has become imperative. In this research, the smallholder farmers are therefore considered to be those producers who have four (4) hectares of landholding.

Three different definitions about small-scale farmers were mentioned by Cervantes-Godoy (2015). These definitions either vary or concur to land area, socioeconomic status, revenues and countries. A definition considered a smallholder is "a farmer (crop or livestock) practicing a mix of commercial and subsistence production…, where family provides the majority of labor and the farm provides the principal source of income". Meanwhile, in a Food and Agriculture Organization (FAO) study in 2004, their definition was according to limitation to access financial resources. But the World Bank definition in 2003 has added farmers who are occupying and farming less than two (2) hectares.

Smallholdings are usually defined in official statistics as land holdings under 40 hectares, in some countries 20 hectares in most. However, in Southeast Asia, perennial cash crop smallholdings usually cover between one to four hectares (Fox and Castella 2013), even if at times some authors have set the upper limit much higher. Smallholdings are better defined by their qualitative characteristics, which is their primary reliance on family labor, or at least on a small labor force that does not require bureaucratic management structures, which is the case with large holdings (Bissonnette and De Koninck, 2015). Different countries and context have their view of what constitutes or defines a smallholder as is reflected in Table 1.2.

Table 1.2 : Definition of Smallholder Farmers by Country

Country	Smallholders Definition (Hectares)	Smallholdings Production Share (%)
Malaysia	Less than 40.5	93.0
Myanmar	Less than 8 (not legal limit)	90.5
Thailand	Less than 40	90.5
India	Less than 20	88.4
Indonesia	Less than 25	85.0
Sri Lanka	Less than 20	64.0
Laos	Less than 25	23.0

(Source : Fox and Castella, 2013)(Fox and Castella, 2013)

For the most parts of Indonesia's and Malaysia's rubber plantations, they are operated and possessed by smallholders and large estates, whilst in Thailand the dominant group of producers are exclusively smallholders (Phommexay et al., 2011). Equally, Arshad (2016) asserted that 94% of the rubber planted area in Malaysia is being operated by smallholders. Further, Table 1.3 illustrates the main NR producing sectors in Malaysia and their production levels.

Table 1.3 : Malaysian Rubber Smallholders and Estates Land Control and Production 2013-2015

	2013		2014		2015	
	Land control (000) ha	**Production (000) tons**	**Land control (000) ha**	**Production (000) tons**	**Land control (000) ha**	**Production (000) tons**
Smallholders	747.6	769.0	747.6	612.8	747.6	655.1
Estates	77.4	57.4	80.1	55.8	76.8	57.0
Total	825.0	826.4	827.7	668.6	824.4	722.1

(Source : Annual NR Statistics 2016, Department of Statistics, Malaysia)

These smallholders are responsible for more than 90% of the NR production in Peninsular Malaysia, which makes them the main dominator and contributor to Malaysian economy (Ali, Osman and Ibrahim, 2015). Furthermore, Figure 1.2, illustrates the smallholders' average yields of NR kg/ha fluctuation and declination over 2010-2016 ("Malaysia: Average Yield of NR by Sector," 2017).

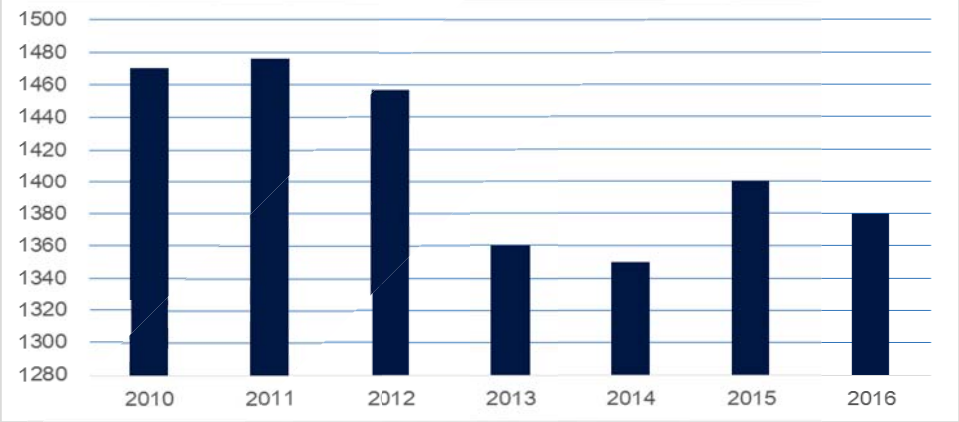

Figure 1.2 : Malaysian Rubber Smallholders Sector Average NR Yield

This provoked the government of Malaysia and geared to support this sector through policies and National plans, especially the period after the independence of Malaysia to present. These initiatives focused on land increasing for industrial crops, increase production by investing new technologies in the production process and alleviating farmers' poverty, over than above, insuring the conservation and the utilization of natural resources (Dardak, 2015; Matahir and Tuyon, 2013). As it is clear for the government, that the country's agricultural future depends on the future of the smallholders which are less efficient and productive than big plantations due to lack of innovation and research (Arshad, 2016). Also, given the decreasing in the Malaysian rubber plantations area, both estates and smallholders as it had dropped 32.24% between 1990 and 2009 (Ratnasingam, Ioras and Wenming, 2011). By

comparison, the continuity in land control and production the rubber smallholdings operators remain the prime producer of NR.

Consequently, MRB and RISDA exist for the preferment of this sector in terms of R&D, extension and technology transfer were invested in KTR program as an extension method or medium for dissemination and adoption of Good Agricultural Practices (GAP), which were proven positive methods to improve NR growers' capacity. Tey et al. (2015) had found that the GAP certification scheme was overwhelmingly seen by farmers as a means to achieve the core personal value of a ''better life''. Participation in this scheme was regarded as a strategic investment, particularly to those vegetable farmers taking part in the Permanent Food Park Scheme. Compliance with GAP principles was seen beneficial in improving the quality of their farm produce, leading them to enjoy various business advantages. Key factors amongst these were improved food safety, higher selling prices, enhanced ability to export, boosted consumers' confidence, better marketability and higher sales. All these business advantages were considered to generate more farm profits. This enhanced financial position was seen as necessary to support family and business expansion, thus improving the state of living.

1.5 Kampung Teknologi RISDA (KTR) Program

The KTR program has also such efforts that are designed to solve the problem of declining productivity in the NR industry in the country. The 10th MDP report clearly highlights a further decline which may linger further to 3.0% per annum. This fall is attributed to the declination in productivity and saw logs area. It is hoped that a structural change will bring a drive to the sector's output, productivity and value addition significantly and thus seen as the ultimate solution to the program. The KTR project is designed to promote the adoption of new technologies and promote a shift in the production scale among the NR producers. The need for commercialization, expansion and integrated cultivation system, with an increase access to wider commodity markets, are seen as the key issues to tackle, thereby forming the cardinal basis for action in RISDA KTR. Hence, RISDA deployed the KTR in the year 2012 to transfer technologies and to achieve the production of 2000 kg NR per hectare by 2020. Among the primary objectives of KTR:

1) To present new technologies inform of GAPs which are based on four (4) foundation bases of conceptual standards: food safety and quality, environmental sustainability, social acceptability and economic viability. The GAPs practices are: Fertilization, Maintenance, Stimulation and Tapping. Two (2) types of tapping were mainly introduced, the Basic and the Low Intensity Tapping System (LITS).
2) To plant and replant new improved clones, with RISDA providing tested, certified and approved high productive clones classified as class I and II, where the latter are less fully tested and less stable and approved clones.
3) RISDA is also saddled with the responsibilities of attracting young farmers to this industry and also distribute subsidies to rubber smallholders i.e. seedlings, fertilizers, rain busters and RM5,000 per year for each KTR program to manage the new technology application.

These activities have no secretariat or specific venues, but producers are informed or communicated through small holder leadership, extension officers and it is mostly through the face to face method of communication and grouped. The practice is more like farm visit approach of extension, where meetings are usually done on the farm. In this approach, the producers are gathered on a farm that is deemed a leader and/or an early adopter that complies with previous RISDA recommendations. The farm issues are tackled and solved, and the training on a new technology is being done and/or demonstrated by a qualified extension officer(s) or subject matter specialist.

Variant trainings are given on different technologies based on groupings. In other words, trainings are not run uniformly and on a common technology, but rather approached differently based on the issues as applied to the different groups. The program will be continuously run by RISDA until all topics are covered and then the extension worker will decide whether the training is to be continued or satisfactorily achieved. RISDA depends on the state department's and productivity records and on the agents' four (4) farm visits per year. However, KTR programs have not been very well evaluated and interventions were not evaluated after the program finished. Hence, participants' contribution would empower this assessment. The pervious information related to KTR program is based on the interview dated on 21st of Feb.2017 with Mr. Ronni Pasla Bin Mohamed Yusoff, Chief Assistant Director, Department of Technology Development and Transfer, RISDA.

In summary, despite the wide view upon evaluation, an argument still stands regarding it is for proving or improving. If the evaluation is aimed to justify an investment, the view can be looked at it is aimed to prove. Whereas, if the purpose aimed for discovering new approaches and sharing it with other it means we are improving not just the studied issues but contributing to the body of knowledge and to those professionals involve in the program (Rennekamp and Arnold, 2009).

1.6 Problem Statement

Based on the early established facts, the Malaysian government has invested significantly in the promotion and support of the rubber plantations and as such national strategies and plans were deployed and implemented towards that effect. In fact, in line with the goals of making the agricultural sector the third engine of growth of the economy, the government has implemented different programs. It is hoped that this will elevate the producers' income and the extension of their livelihood, while preserving and assuring sustenance to the natural resources.

In this vein, there are a lot of programs that RISDA implemented in the line of planting and replanting with a high yielding clones programs, done in close collaboration with MRB. The KTR program, which was launch in 2012, also has done a lot, as an extension medium, for rubber smallholders' capacity building, transferring applied new technologies, incentives and subsidies distribution. Alongside, with a number of programs and workshops were implemented to achieve farm yield of 2,000 kg/ha/year by the year of 2020 and to attract young farmer generation to this industry. Although, there are challenges to gauge the success of such programs to achieve their intended goals. Besides the scarce assessments that have been carried out. Hence, to confront the causes, of scientific nature obstructing the program and intensifying those supporting it.

The rubber smallholders are the backbone of NR production in Malaysia and the deliberate proactive attention and effective mechanisms are deployed continuously to develop this sector. The NR industry has been listed among the 12 sectors of NKEA, which has highlighted the implementation of four (4) key Entry Point Projects (EPPs), to ensure the sustainability of the upstream sector, to increase world market share of NR to 65% by 2020 and to commercialize Green Rubber (Nalini et al., 2014). It is worthy of mentioning that increased productivity is a function of the level of technology adopted, followed by the human and organizational factors. Perception is one substantial human factor that significantly influence the farmers' decision-making towards any experience they would endure. Consequently, effecting any planned outcomes targeting their wellbeing positively or negatively. This is based on, if one perceives to have little to no impact on something, self-efficacy will be low and in turn effect the beliefs and actions taken to create an impact (Coleman and Karraker, 1998).

Accordingly, the farmers' perceptions towards the new innovations, program and towards the implementer. In addition to their consequent perceived impact are considered vital elements towards the success of the KTR program. Yet, the tool of evaluation is essential and supports the telling of a convincing story of the program expected performance (McLaughlin and Jordan, 1999).

Similarly, the extension programs have been revolutionized by an increased expectation and demand for success. The business of providing food and industrial input is no longer considered lightly. As such, the demand is for programs, projects and all efforts to be evaluated and assessed on the scale of success or otherwise for possible adjustment and decisions by the managers. The success of such programs are scrutinized based on measurable objectives and outcomes (McCann, Peterson and Gold, 2009).

Although, the traditional system of evaluation has been accused of being too simplistic and based on description of the demographics and percentages of participants. Most program evaluations simply stop at the reaction level (reports on inputs, activities, people involvement and reactions) or learning i.e. knowledge, attitude, skills and aspiration, without measuring higher level changes, as the higher the level of evaluation the higher the difficulty, complexity and more expensive it will become (Aziz, 2015; Workman and Scheer, 2012).

It therefore became obvious that the evaluation of KTR program has become imperative in order to improve the activities achievements. The impact evaluation based on the respondents' perspective and from a neutral party will bring forth salient gaps, issues and impetus to stakeholders requiring development and enforcement.

In sum, for all these goals to be realized, there is an essential need for evaluation to measure and explain the impact of the intervention. Generally, all developmental programs and policies are formed and implemented with the sole aim of changing outcomes, especially in extension programs, whose main aim is to increase productivity as a route for life betterment. It is therefore among the virtues of evaluations of an adopted method or approach to explicate the extent of KTR program effectiveness to its stakeholders. To fortify current initiatives Along with, the dissemination of upcoming future developed approaches. Therefore, the researcher imposed the following questions:

1) What is the KTR respondents' perception level towards KTR program, towards KTR's technology and towards extension activities?
2) What is the respondents' perceived impact (changes) level towards KTR?
3) What evidence of change (outcomes) can be found related to KTR program impact?
4) What are the relationships between the perception towards KTR program, towards KTR's technology and towards extension activities and the perceived impact (changes) of KTR program?
5) What are the influences and relationships between selected socio-demographic factors determinants, perception towards KTR program, perception towards KTR's technology and perception towards extension activities and the perceived impact of KTR program?

1.7 Study Objectives

1.7.1 General Objective

The general objective of the study is to study the extent of the KTR program effect on KTR's participants and the pre-set KTR's objectives.

1.7.2 Specific Objectives

The specific objectives of the study are:

1) To identify the KTR respondents' perception level towards KTR program, towards KTR's technology and towards extension activities.
2) To determine the respondents' perceived impact level towards KTR program.
3) To identify evidence of change (outcomes) related to KTR program impact.
4) To identify the relationships between the perception towards KTR program, perception towards KTR's technology and perception towards extension activities and the perceived KTR impact.
5) To identify the influences and relationships between selected socio-demographic factors, perception towards KTR program, perception towards KTR's technology and perception towards extension activities and the respondents' perceived impact of KTR program.

1.8 Significance of the Study

The research hopes to highlight the level of achievement or otherwise of the KTR program with an aim to help in the provision of valid information for the betterment of the programs and ultimate goal achievement. As it is generally known, the evaluation research is solely to determine whether the set goals are achieved or the needs being met by the activities.

This study also makes use of the evaluation model that is well accepted in extension as being easy to use and effective. It is known to be applied on the development of programs as well as developing more details in the program evaluation and improvement plans. The findings of the study will be of benefit to RISDA, the government, extension officers and educational administrators and planners, researchers and the society at large.

1.9 Structure of the Thesis

This dissertation comprised of five (5) chapters. Chapter One included the following topics: agriculture and NR industry in Malaysia, NR industry smallholders developing authority (RISDA), smallholders of rubber, kampung technology RISDA (KTR) program, problem statement, significance of the study and finally the structure of the thesis.

Chapter Two covered the literature and past and recent studies on agriculture extension, technology transfer and adoption, program evaluation, program evaluation theory and evaluation models.

Chapter Three presented the study population, sampling techniques and area covered by this research, in addition to the research's design, analysis methods and the applications been used to derive the empirical results. Chapter Four will displayed research's results, its analysis and discussion.

Chapter Five is where the key study findings, conclusions and limitations were concluded. In addition to the suggested recommendations that will guide future researchers and stakeholders to better program development.

REFERENCES

Abdullah, F. A. & Samah, B. A. (2013). Factors Impinging Farmers' Use of Agriculture Technology. *Asian Social Science, 9*(3), 120-124.

Abdullah, R. B. (1977). Some extension and training aspects of rubber smallholders in Malaysia. *Rubber Research Institute of Sri Lanka*(54), 433-444.

Acharya, A. S., Prakash, A., Saxena, P. & Nigam, A. (2013). Sampling: Why and how of it. *Indian Journal of Medical Specialties, 4*(2), 330-333.

Adesina, A. A. & Baidu-Forson, J. (1995). Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa. *Agricultural economics, 13*(1), 1-9.

Ahmad, T. & Suntharalingam, C. (2009). Transformation and economic growth of the Malaysian Agricultural Sector. *Economic and Technology Management Review, 4*, 1-10.

Akudugu, M. A., Guo, E. & Dadzie, S. K. (2012). Adoption of modern agricultural production technologies by farm households in Ghana: What factors influence their decisions. *Journal of biology, agriculture and healthcare, 2*(3), 1-13.

Ali, H. & Davies, D. R. (2003). The effects of age, sex and tenure on the job performance of rubber tappers. *Journal of Occupational and Organizational Psychology, 76*(3), 381-391.

Ali, M. F. B., Osman, R. B. & Ibrahim, N. B. (2015). Factors Associated with Adoption of Stimulation Technology by Rubber Smallholders in Malaysia. *International Academic Research Journal of Social Science, 1*(2), 150-156.

Altieri, M. A., Funes-Monzote, F. R. & Petersen, P. (2012). Agroecologically efficient agricultural systems for smallholder farmers: contributions to food sovereignty. *Agronomy for Sustainable Development, 32*(1), 1-13.

Anderson, J. R. & Feder, G. (2004). Agricultural extension: Good intentions and hard realities. *The World Bank Research Observer, 19*(1), 41-60.

Arshad, F. M. (2016). The Need for Pro-smallholder Policy in Malaysia*6*. Retrieved from http://searca.org/knowledge-resources/1603-pre-download?pid=310 website: http://searca.org/

Arvidson, M. & Kara, H. (2013). Putting evaluations to use: from measuring to endorsing social value. Retrieved from http://epapers.bham.ac.uk/1851/1/WP110_Arvidson_and_Kara.pdf

Aslam, M. & Hassan, A. A. G. (2003). *Development planning and regional imbalances in Malaysia*. Paper presented at the 9th International Planning History Conference, Helsinki University of Technology, Finland.

Azhar, B., Lindenmayer, D. B., Wood, J., Fischer, J., Manning, A., Mcelhinny, C. & Zakaria, M. (2013). The influence of agricultural system, stand structural complexity and landscape context on foraging birds in oil palm landscapes. *Ibis, 155*(2), 297-312.

Aziz, S. F. A. (2015). Developing general training effectiveness scale for the Malaysian workplace learning. *Mediterranean Journal of Social Sciences, 6*(4), 47-56.

Azman, A., Silva, J. L. D., Samah, B. A., Man, N. & Shaffril, H. A. M. (2013). Relationship between attitude, knowledge, and support towards the acceptance of sustainable agriculture among contract farmers in Malaysia. *Asian Social Science, 9*(2), 99-105.

Baffoe-Asare, R., Danquah, J. A. & Annor-Frempong, F. (2013). Socioeconomic factors influencing adoption of CODAPEC and cocoa high-tech technologies among small holder farmers in Central Region of Ghana. *American Journal of Experimental Agriculture, 3*(2), 277-292.

Beneitone, P. & Yarosh, M. (2015). Tuning impact in Latin America: is there implementation beyond design? *Tuning Journal for Higher Education, 3*(1), 187-216.

Bissonnette, J.-F. & De Koninck, R. (2015). *Large Plantations versus Smallholdings in Southeast Asia: Historical and Contemporary Trends*. Paper presented at the Land Grabbing, Conflict and Agrarian-Environmental Transformations: Perspective from East and Southeast Asia, Chiang Mai University, Thailand.

Black, A. (2000). Extension theory and practice: a review. *Animal Production Science, 40*(4), 493-502.

Boone, H., Hersman, E. M., Boone, D. A. & Gartin, A. (2007). Knowledge of sustainable agriculture practices by extension agents in Ohio, Pennsylvania and West Virginia. *Journal of Extension, 45*(5), 1-7.

Boynton, P. M. (2004). Administering, analysing, and reporting your questionnaire. *BMJ : British Medical Journal, 328*(7452), 1372-1375.

Braverman, M. T. & Engle, M. (2009). Theory and rigor in Extension program evaluation planning. *Journal of Extension [online], 47*(3), 1-10.

Brinkerhoff, D. W. & Goldsmith, A. A. (1992). Promoting the sustainability of development institutions: A framework for strategy. *World Development, 20*(3), 369-383.

Brodie, L., Bullen, F. & Jolly, L. (2011). *Effective evaluation strategies to meet global accreditation requirements*. Paper presented at the Frontiers in Education Conference (FIE), 2011.

Brousselle, A. & Champagne, F. (2011). Program theory evaluation: Logic analysis. *Evaluation and program planning, 34*(1), 69-78.

Cafarella, R. (2001). Developing effective learning programs for adults. *APC Monographs, 5*, 1-12.

Chan, C. H., Joy, J., Maria, H. J. & Thomas, S. (2013). Natural Rubber-Based Composites and Nanocomposites: State of the Art, New Challenges and Opportunities. *Natural Rubber Materials: Volume 2: Composites and Nanocomposites* (pp. 1-33): Royal Society of Chemistry.

Chi, T. T. N. & Yamada, R. (2002). Factors affecting farmers' adoption of technologies in farming system: A case study in Omon district, Can Tho province, Mekong Delta. *Omonrice, 10*, 94-100.

Choi, H. J. (2009). Technology transfer issues and a new technology transfer model*35*. Retrieved from Digital Library and Archives website: http://scholar.lib.vt.edu/ejournals/JOTS/v35/v35n1/choi.html

Coleman, P. K. & Karraker, K. H. (1998). Self-efficacy and parenting quality: Findings and future applications. *Developmental review, 18*(1), 47-85.

Cooksy, L. J., Gill, P. & Kelly, P. A. (2001). The program logic model as an integrative framework for a multimethod evaluation. *Evaluation and program planning, 24*(2), 119-128.

Cornelia, D. C. C. C. L. & Graham, L. (2016). Planning an integrated agriculture and health program. *Development in Practice, 20*(8), 946-958.

Coryn, C. L., Noakes, L. A., Westine, C. D. & Schröter, D. C. (2011). A systematic review of theory-driven evaluation practice from 1990 to 2009. *American journal of Evaluation, 32*(2), 199-226.

Dardak, R. A. (2015). Transformation of Agricultural Sector in Malaysia Through Agricultural Policy, 7. Retrieved from http://ap.fftc.agnet.org/ap_db.php?id=386

Davis, K. (2008). Extension in sub-Saharan Africa: Overview and assessment of past and current models and future prospects. *Journal of International Agricultural and Extension Education, 15*(3), 15-28.

Davis, K., Nkonya, E., Kato, E., Mekonnen, D. A., Odendo, M., Miiro, R. & Nkuba, J. (2012). Impact of farmer field schools on agricultural productivity and poverty in East Africa. *World Development, 40*(2), 402-413.

de Souza, L. M., Le Guen, V., Cerqueira-Silva, C. B. M., Silva, C. C., Mantello, C. C., Conson, A. R. O., . . . de Freitas Fialho, J. (2015). Genetic diversity strategy for the management and use of rubber genetic resources: more than 1,000 wild and cultivated accessions in a 100-genotype core collection. *PloS one, 10*(7), e0134607.

Diederen, P., van Meijl, H. & Wolters, A. (2003). Modernisation in agriculture: what makes a farmer adopt an innovation? *International Journal of Agricultural Resources, Governance and Ecology, 2*(3-4), 328-342.

Diederen, P., Van Meijl, H., Wolters, A. & Bijak, K. (2003). Innovation adoption in agriculture: innovators, early adopters and laggards. *Cahiers d'économie et sociologie rurales, 67*, 30-50.

Duerden, M. D. & Witt, P. A. (2012). Assessing program implementation: What it is, why it's important, and how to do it. *Journal of Extension, 50*(1), 1-8.

Economic Transformation Programme Annual Report 2014. (2015). Jabatan Perdana Menteri: Prime Minister's Department Retrieved from https://www.pemandu.gov.my/assets/publications/annual-reports/ETP_2014_EN.pdf.

Etling, A., Radomski, C., Holt, M. & Paik, B. (2002). ASEAN/USDA Entrepreneurship Development. *Association for International Agricultural and Extension Education*, 382-389.

FAO. (2013). *St. Kitts Agricultural Development Strategy*

(ADS) 2013 – 2016. Retrieved from http://www.fao.org/faolex/results/details/en/c/LEX-FAOC141099/:

FAO. (2018). *Crops, Natural Rubber.* Retrieved from http://www.fao.org/faostat/en/#data/QC

Farjad, S. (2012). The Evaluation Effectiveness of training courses in University by Kirkpatrick Model (case study: Islamshahr university). *Procedia-Social and Behavioral Sciences, 46*, 2837-2841.

Firuza, B. M. G., M. S.; Nather Khan, I.; Khairul., O. S. (2011). Paper presented at the International Conference On Population Dynamism Of Asia, University of Malaya. https://umexpert.um.edu.my/file/publication/00009780_72330.pdf

Fox, J. & Castella, J.-C. (2013). Expansion of rubber (Hevea brasiliensis) in Mainland Southeast Asia: what are the prospects for smallholders? *The Journal of Peasant Studies, 40*(1), 155-170.

Franz, N. K., Garst, B. A. & Gagnon, R. J. (2015). The Cooperative Extension Program Development Model: Adapting to a Changing Context. *Journal of Human Sciences and Extension, 3*(2), 3-12.

Frye, A. W. & Hemmer, P. A. (2012). Program evaluation models and related theories: AMEE Guide No. 67. *Medical teacher, 34*(5), e288-e299.

Gagnon, R. J., Franz, N. K., Garst, B. A. & Bumpus, M. F. (2015). Factors impacting program delivery: The importance of implementation research in Extension. *Journal of Human Sciences and Extension, 3*(2), 68-82.

Garbarino, S. & Holland, J. (2009). Quantitative and qualitative methods in impact evaluation and measuring results. Retrieved from http://www.gsdrc.org/docs/open/EIRS4.pdf

Gertler, P. J., Martinez, S., Premand, P., Rawlings, L. B. & Vermeersch, C. M. (2011). *Impact evaluation in practice*: World Bank Publications.

Ghane, F., Samah, B. A., Ahmad, A. & Idris, K. (2011). *The role of social influence and innovation characteristics in the adoption of Integrated Pest Management (IPM) practices by paddy farmers in Iran.* Paper presented at the Proceedings of the International Conference on Social Science and Humanity.

Ghimire, N. R. & Martin, R. A. (2011). Needs Assessment Competencies: Are They Important for Extension Educators? *International Journal of Agricultural Management & Development, 1*(3), 139-155.

Giersch, U. & Kubisch, U. (1995). The Exploitation of Natural Rubber (M. J. R. Loadman, Trans.) *Gummi – die elastische Faszination*. Berlin, Nicolai 1995.

Gliem, J. A. & Gliem, R. R. (2003). *Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales.* Paper presented at the Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education, Ohio State University, Columbus, OH.

Goldthorpe, C. C. (2015). *Rubber Manufacturing in Malaysia: Resource-based Industrialization in Practice*. Singapore: NUS Press.

Guerra-López, I. & Hicks, K. (2015). The participatory design of a performance oriented monitoring and evaluation system in an international development environment. *Evaluation and program planning, 48*, 21-30.

Hamid, H. (2012). *Selected factors influencing impact of agriculture land development programme on Orang Asli community in Pahang, Malaysia.* (Master Thesis), Universiti Putra Malaysia.

Hamid, H., Samah, A. A. & Man, N. (2013). The level of perceptions toward agriculture land development programme among Orang Asli in Pahang, Malaysia. *Asian Social Science, 9*(10), 151-159.

Hamilton, A. & Hudson, J. (2017). The perceived impact of agricultural advice in Ethiopia. *The Journal of Agricultural Education and Extension, 23*(2), 159-173.

Hassan, M. S., Shaffril, H. A. M., Samah, B. A., Ali, M. S. S. & Ramli, N. S. (2010). Agriculture communication in Malaysia: The current situation. *American Journal of Agricultural and Biological Sciences, 5*(3), 389-396.

Hassan, S., Kasin, R. & Oluwatoyin, O. (2017). Factors Influencing Cocoa Farmers Smallholder Clusters in Adoption of Technology: A Review Paper. *Journal of Agriculture and Veterinary Science (IOSR-JAVS), 10*(7), 34-39.

Hayes, H., Parchman, M. L. & Howard, R. (2011). A logic model framework for evaluation and planning in a primary care practice-based research network (PBRN). *The Journal of the American Board of Family Medicine, 24*(5), 576-582.

Hazir, M. H. M. & Muda, T. M. T. (2016). *Geospatial application for the identification and monitoring of rubber smallholders in the Malaysian state of Negeri Sembilan.* Paper presented at the IOP Conference Series: Earth and Environmental Science.

Helitzer, D., Willging, C., Hathorn, G. & Benally, J. (2009). Using Logic Models in a Community-Based Agricultural Injury Prevention Project. *Public Health Reports, 124*(Suppl 1), 63-73.

Hendriks, M. (2004). *Managing risks in implementation of information communication technology in developing countries.* (Master Thesis), Radboud university, Nijmegen, the Netherlands. (09 IK)

Hill, J. R. & Thies, J. (2010). Program theory and logic model to address the co-occurrence of domestic violence and child maltreatment. *Evaluation and program planning, 33*(4), 356-364.

Hill, R. (1998). What sample size is "enough" in internet survey research. *Interpersonal Computing and Technology: An electronic journal for the 21st century, 6*(3-4), 1-12.

Hilmi, M. F., Ramayah, T., Mustapha, Y. & Pawanchik, S. (2010). Product and process innovativeness: evidence from Malaysian SMEs. *European Journal of Social Sciences, 16*(4), 556-564.

Hinkin, T. R. (1998). A brief tutorial on the development of measures for use in survey questionnaires. *Organizational research methods, 1*(1), 104-121.

Hopkins, W. G. (2008). Quantitative research design. *SPORTSCIENCE, 4*. Retrieved from http://sportsci.org/2000/1/index.html website: http://sportsci.org

Idowu, O. O. (2005). Farmers' perception of agricultural extension agents' characteristics as factors for enhancing adult learning in Mezam division of Northwest Province of Cameroon. *Australian Journal of Adult Learning, 45*(2), 223-237.

Israel, G. D. (2001). Using Logic Models for Program Development (Vol. AEC360, pp. 4): http://edis.ifas.ufl.edu/.

Jadalla, A. E. O., Bakar, A. H. A., Jais, H. M. & Shalloof, F. M. (2013). The improve of agricultural extension programs in Eastern Libya for the achievement of sustainable agricultural development. *Australian Journal of Basic and Applied Sciences, 7*(7), 240-249.

Jamil, M. A., Khan, N., Khan, F. & Zakria, M. (2015). Effectiveness of agricultural extension services in dissemination of information to the farming community of district bhimber, azad jammu and kashmir. *Pakistan Journal of Agricultural Research, 28*(2), 210-216.

Järvelin, K., Vakkari, P., Arvola, P., Baskaya, F., Järvelin, A., Kekäläinen, J., . . . Savolainen, R. (2015). Task-based information interaction evaluation: The viewpoint of program theory. *ACM Transactions on Information Systems (TOIS), 33*(1). Retrieved from https://tois.acm.org/archive.cfm?id=2737806 website: https://tois.acm.org/index.cfm

Johanson, G. A. & Brooks, G. P. (2010). Initial scale development: sample size for pilot studies. *Educational and Psychological Measurement, 70*(3), 394-400.

Kabwe, G. (2010). *Uptake of agroforestry technologies among smallholder farmers in Zambia.* (PhD Thesis), Lincoln University, New Zealand.

Kameli, S. & Baki, R. B. (2013). The impact of vocabulary knowledge level on EFL reading comprehension. *International Journal of Applied Linguistics and English Literature, 2*(1), 85-89. doi:http://dx.doi.org/10.7575/ijalel.v.2n.1p.85

Karuhanga, M., Kiptot, E. & Franzel, S. (2012). *The effectiveness of the farmer trainers approach in technology dissemination in the East Africa Dairy Developmnent project in Uganda: A study of volunteer farmer trainers*. Retrieved from https://cgspace.cgiar.org/discover

Kassie, M., Teklewold, H., Jaleta, M., Marenya, P. & Erenstein, O. (2015). Understanding the adoption of a portfolio of sustainable intensification practices in eastern and southern Africa. *Land Use Policy, 42*, 400-411.

Kim, J. & Seo, B. S. (2013). How to Calculate Sample Size and Why. *Clinics in Orthopedic Surgery, 5*(3), 235-242.

Lin, R. M. (2009). Ex post impact assessment of pineapple technology on peat soil. *Economic and Technology Management Review, 4*, 25-35.

Liu, H. S., Mead, J. L. & Stacer, R. G. (1998). *Environmental impacts of recycled rubber in light fill applications: summary & evaluation of existing literature*: UMass Lowell, Chelsea Center for Recycling and Economic Development.

Logsdon, R. A., Kalcic, M. M., Trybula, E. M., Chaubey, I. & Frankenberger, J. R. (2015). Ecosystem services and Indiana agriculture: farmers' and conservationists' perceptions. *International Journal of Biodiversity Science, Ecosystem Services & Management, 11*(3), 264-282.

Malaysia map with states. (N.d.). Retrieved from http://malaysiamap.facts.co/malaysiamapof/malaysiamap.php

Malaysia: Average Yield of NR by Sector. (2017). Retrieved from http://www.data.gov.my/

Marantidou, A., Michailidis, A. & Papadaki-Klavdianou, A. (2011). Information and Communication technologies as agricultural extension tools. *Scientific Bulletin-Economic Sciences, 10*(1), 114-125.

Matahir, H. & Tuyon, J. (2013). The Dynamic Synergies between Agriculture Output and Economic Growth in Malaysia. *International Journal of Economics and Finance, 5*(4), 61-70.

McCann, A., Peterson, J. & Gold, A. J. (2009). Using planning and evaluation tools to target Extension outputs & outcomes: The New England private well symposium example. *Journal of Extension [online], 47*(3), 29-48.

McCrum-Gardner, E. (2010). Sample size and power calculations made simple. *International Journal of Therapy and Rehabilitation, 17*(1), 10-14.

McLaughlin, J. A. & Jordan, G. B. (1999). Logic models: a tool for telling your programs performance story. *Evaluation and program planning, 22*(1), 65-72.

McNamara, G., Joyce, P. & O'Hara, J. (2010). Evaluation of adult education and training programs. *International Encyclopedia of Education, 3*, 548-554.

Meijer, S. S., Catacutan, D., Ajayi, O. C., Sileshi, G. W. & Nieuwenhuis, M. (2015). The role of knowledge, attitudes and perceptions in the uptake of agricultural and agroforestry innovations among smallholder farmers in sub-Saharan Africa. *International Journal of Agricultural Sustainability, 13*(1), 40-54. doi:10.1080/14735903.2014.912493

Menike, T., Rupasena, L. & Bandara, A. (2015). *Access and Use of Information by Smallholder Rubber Farmers in Warakapola Divisional Secretariat Area*. Paper presented at the Third International Research Symposium, Rajarata University of Sri Lanka.

Mignouna, D., Manyong, V., Rusike, J., Mutabazi, K. & Senkondo, E. (2011). Determinants of adopting imazapyr-resistant maize technologies and its impact on household income in Western Kenya. *Journal of Development and Agricultural Economics, 3*(11), 572-580.

Murage, A. W., Pittchar, J., Midega, C., Onyango, C. & Khan, Z. (2015). Gender specific perceptions and adoption of the climate-smart push–pull technology in eastern Africa. *Crop Protection, 76*, 83-91.

Mustapha, N. (2011). Technical efficiency for rubber smallholders under RISDA's supervisory system using stochastic frontier analysis. *Journal of Sustainability Science and Management, 6*(1), 156-168.

Muzari, W., Gatsi, W. & Muvhunzi, S. (2012). The impacts of technology adoption on smallholder agricultural productivity in sub-Saharan Africa: a review. *Journal of Sustainable Development, 5*(8), 69-77. doi:10.5539/jsd.v5n8p69

Nair, K. P. (2010). *The agronomy and economy of important tree crops of the developing world*: Elsevier.

Nalini, A., Izah, M., Malik, A. & Musa, W. W. (2014). Factors that Influenced the Effectiveness of Transfer of Technology (TOT) Programme among Rubber Small Holder in Malaysia. *Journal of Agriculture and Sustainability, 6*(1), 1-13.

Nordvall, M. & Arvola, M. (2016). *Perception, Meaning and Transmodal Design*. Paper presented at the Design Research Society 50th Anniversary Conference, 2016, Brighton, UK. http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-129023

Obiero, E. O. (2013). *Social economic factors affecting farm yield in Siaya District, Siaya County, Kenya.* (Masters of Arts Degree in Project Planning and Management), University of Nairobi, Kenya.

Olofsson, P., Foody, G. M., Herold, M., Stehman, S. V., Woodcock, C. E. & Wulder, M. A. (2014). Good practices for estimating area and assessing accuracy of land change. *Remote Sensing of Environment, 148*, 42-57.

Perrin, B. (2012). Linking Monitoring and Evaluation to Impact Evaluation(2). Retrieved from https://www.interaction.org/resources/training/guidance-note-2-linking-monitoring-and-evaluation-impact-evaluation website: https://www.interaction.org/

Phommexay, P., Satasook, C., Bates, P., Pearch, M. & Bumrungsri, S. (2011). The impact of rubber plantations on the diversity and activity of understorey insectivorous bats in southern Thailand. *Biodiversity and Conservation, 20*(7), 1441-1456.

Qi, D., Zhou, J., Xie, G. & Wu, Z. (2014). Studies on rubber (Hevea brasiliensis) trees exist plant type after planting and available tapping tree of rubber plantation in China. *American Journal of Plant Sciences, 5*(20), 3017-3021.

Ratnasingam, J., Ioras, F. & Wenming, L. (2011). Sustainability of the rubberwood sector in Malaysia. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 39*(2), 305-311.

Razak, S. B. A., Aziz, A. A., Ali, N. A., Ali, M. F. & Visser, F. (2016). *The sustainable integration of meliponiculture as an additional income stream for rubber smallholders in Malaysia*. Paper presented at the CRI & IRRDB International Rubber Conference, Siem Reap, Cambodia.

Rennekamp, R. A. & Arnold, M. E. (2009). What progress, program evaluation? Reflections on a quarter-century of Extension evaluation practice. *Journal of Extension, 47*(3). Retrieved from https://www.joe.org/joe/2009june/index.php website: https://www.joe.org/

Rodrigo, V. (2007). Ecophysiological factors underpinning productivity of Hevea brasiliensis. *Brazilian Journal of Plant Physiology, 19*(4), 245-255.

Rogers, E. M., Takegami, S. & Yin, J. (2001). Lessons learned about technology transfer. *Technovation, 21*(4), 253-261.

Rogers, P. J. (2008). Using programme theory to evaluate complicated and complex aspects of interventions. *Evaluation, 14*(1), 29-48.

Rogers, P. J. (2012). Introduction to impact evaluation(1). Retrieved from https://www.interaction.org/resources/training/guidance-note-1-introduction-impact-evaluation website: https://www.interaction.org/

Rogers, P. J., Petrosino, A., Huebner, T. A. & Hacsi, T. A. (2000). Program theory evaluation: Practice, promise, and problems. *New directions for evaluation, 2000*(87), 5-13.

Röling, N. & Van De Fliert, E. (1994). Transforming extension for sustainable agriculture: the case of integrated pest management in rice in Indonesia. *Agriculture and Human Values, 11*(2-3), 96-108.

Roucan-Kane, M. (2008). Key facts and key resources for program evaluation. *Journal of Extension, 46*(1). Retrieved from https://www.joe.org/joe/2008february/index.php website: https://www.joe.org/

Roy, R. & Chan, N. W. (2012). An assessment of agricultural sustainability indicators in Bangladesh: review and synthesis. *The Environmentalist, 32*(1), 99-110.

Ruslan, N. A. (2014). *Vegetable Producer and Wholesaler Attitudes toward Implementing Post-Harvest Practices in Selected States of Peninsular Malaysia.* (Master Thesis), Universiti Putra Malaysia.

Shackman, G. (2008). What is program evaluation? A beginners guide *The Global Social Change Research Project. Retrieved from http://www. ideas-int. org*.

Shaffril, H. A. M., Asmuni, A. & Ismail, A. (2010). The Ninth Malaysian Plan and Agriculture Extension Officer Competency: A Combination for Intensification of Paddy Industry in Malaysia. *Journal of International Social Research, 3*(10), 450-458.

Silverman, B., Mai, C., Boulet, S. & O'Leary, L. (2009). *Logic models for planning and evaluation*. Retrieved from https://www.cdc.gov/ncbddd/birthdefects/models/Resource1-Evaluation-Guide.doc

Sperandei, S. (2014). Understanding logistic regression analysis. *Biochemia medica: Biochemia medica, 24*(1), 12-18.

Stevens, F. (1993). *User-Friendly Handbook for Project Evaluation: Science, Mathematics, Engineering, and Technology Education*. Retrieved from https://eric.ed.gov/?id=ED366511

The Stratification Principle. (N.d.). *STAT 506: Sampling Theory and Methods.* Retrieved from https://onlinecourses.science.psu.edu/stat506/node/28

Suvedi, M., Heinze, K. & Ruonavaara, D. (1999). *How to conduct evaluation of extension programs*. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.205.4406&rep=rep1&type=pdf

Suvedi, M. & Vander Stoep, G. (2016). *Improving the Monitoring and Evaluation of Agricultural Extension Programs*. Retrieved from https://meas.illinois.edu/wp-content/uploads/2016/07/Suvedi-2016-Extension-Evaluation-MEAS-Discussion-Paper.pdf

Taylor-Powell, E. & Henert, E. (2008). *Developing a logic model: Teaching and training guide*. Retrieved from https://fyi.uwex.edu/programdevelopment/files/2016/03/lmguidecomplete.pdf

Taylor- Powell, E. & Boyd, H. H. (2008). Evaluation capacity building in complex organizations. *New directions for evaluation, 2008*(120), 55-69.

Tey, Y. S., Arsil, P., Brindal, M., Shamsudin, M. N., Radam, A., Hadi, A. H. I. A., . . . Lim, C. D. (2015). A Means-End Chain Approach to Explaining the Adoption of Good Agricultural Practices Certification Schemes: The Case of Malaysian Vegetable Farmers. *Journal of Agricultural and Environmental Ethics, 28*(5), 977-990.

Tiraieyari, N., Hamzah, A., Samah, B. A. & Uli, J. (2013). The Importance of the Philosophy, Attitude, Perception, and Knowledge of Extension Workers in Transferring Sustainable Agricultural Practices to Malaysian Farmers. *Asian Social Science, 9*(15), 289-294.

Van der Ploeg, J. D., Renting, H., Brunori, G., Knickel, K., Mannion, J., Marsden, T., . . . Ventura, F. (2000). Rural development: from practices and policies towards theory. *Sociologia ruralis, 40*(4), 391-408.

Van Thanh, N. & Yapwattanaphun, C. (2015). Banana farmers' adoption of sustainable agriculture practices in the Vietnam Uplands: The Case of Quang Tri Province. *Agriculture and Agricultural Science Procedia, 5*, 67-74.

Vengrin, C. A. (2016). *Examining the Evaluation Capacity, Evaluation Behaviors, and the Culture of Evaluation in Cooperative Extension.* (Doctor of Philosophy), Virginia Polytechnic Institute and State University.

Venkatachalam, P., Geetha, N., Sangeetha, P. & Thulaseedharan, A. (2013). Natural rubber producing plants: An overview. *African Journal of Biotechnology, 12*(12), 1297-1310.

Verheye, W. (2010). Growth and production of rubber *Land use, land cover and soil sciences*. Oxford, UK: UNESCO-EOLSS Publishers.

Vermeulen, S. & Goad, N. (2006). *Towards better practice in smallholder palm oil production*. London, UK: International Institute for Environment and Development

Viswanathan, P. & Shivakoti, G. P. (2008). Adoption of rubber-integrated farm-livelihood systems: contrasting empirical evidence from the Indian context. *Journal of Forest Research, 13*(1), 1-14.

Voon, P. K. (1995). The Changing Human Ecology of Smallholding Agriculture in Malaysia. *Chiikigaku Kenkyu Regional views, 8*, 3-15.

Warren- Thomas, E., Dolman, P. M. & Edwards, D. P. (2015). Increasing demand for natural rubber necessitates a robust sustainability initiative to mitigate impacts on tropical biodiversity. *Conservation letters, 8*(4), 230-241. doi:10.1111/conl.12170

Workman, J. D. & Scheer, S. D. (2012). Evidence of Impact: Examination of Evaluation Studies *Journal of Extension, 50*(2). Retrieved from https://www.joe.org/joe/2012april/index.php website: https://www.joe.org/

Xianhai, Z., Mingdao, C. & Weifu, L. (2012). Improving planting pattern for intercropping in the whole production span of rubber tree. *African Journal of Biotechnology, 11*(34), 8484-8490.

Zhong, Y. (2003). *Economic analysis of the Best Management Practices (BMPs) in Louisiana sugarcane production.* Louisiana State University, LSU Digital Commons, http://digitalcommons.lsu.edu/gradschool_theses/3237. (LSU Master's Theses. 3237)