UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF RICE PRODUCTION SUSTAINABILITY INDEX IN MADA, MALAYSIA

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Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

November 2015

DEDICATION

To the glory of Almighty God, the giver of life and knowledge, this study is dedicated to:

My lovely parents,

Pastor E.O Ajidasile and Deaconess M.B Ajidasile

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

DEVELOPMENT OF RICE PRODUCTION SUSTAINABILITY INDEX IN MADA, MALAYSIA

By

AJIDASILE, OLUWAGBEMISOLA HANNAH

November 2015

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

Despite government efforts towards self-sufficiency and sustainable rice production, paddy production is still faced with crucial constraints to attaining high yield in production. Currently, there is over dependence on agricultural chemicals in curtailing pest, insect and weeds in paddy production. The general objective was to develop the overall agricultural sustainability index of rice farmers. The specific objectives were (i) to determine the present production practices, (ii) create sustainability index of rice production, and (iii) to determine factors affecting the sustainability practices of the rice farmers. This study was conducted in MADA area of Peninsular Malaysia.

Four hundred and two randomly selected rice farmers in MADA were surveyed by structured questionnaire supplemented with interview to elicit responses on their various agricultural practices. The data collected were on the demographic characteristics, farmers' production practices, farmers' rationale for (i) insect, disease and weed control, (ii) the fertilization process presently followed by MADA paddy farmers and its sustainable impact on the environment, economic and social practices of the farmers.

Descriptive statistics were used to describe the present production practices of the rice farmers in the study area, the sustainability index were created by assigning scores to the practices and ordinary least square regression analysis, OLS was adopted in examining the factors affecting sustainability practices.

The overall adjusted Agricultural Sustainability Index scores for the 402 farmers ranged from 30.38 to 76.04 (from a total possible range of 0 to 100), with mean of 49. The result indicated that age, level of education, farm size, IPM training were positively significant to sustainability level of the farmers while major occupation and age squared were negatively significant to the farmers sustainability level. The empirical result of the multiple regression analysis shows that there is a strong correlation (R = 0.902) between the factors affecting sustainability and those predicted by the regression model.

Based on the findings, it can concluded that rice production is highly sustainable in the area and the strategy to help the paddy farmers understand the possible reasons for

using less of external inputs were convincing for motivating the farmers to adopt sustainable practice in the MADA

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

PEMBANGUNAN BERAS PENGELUARAN KEMAMPANAN INDEX DALAM MADA, MALAYSIA

Oleh

AJIDASILE, OLUWAGBEMISOLA HANNAH

November 2015

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Walaupun usaha-usaha kerajaan ke arah pencapaian sara diri dan penghasilan beras mampan, pengeluaran padi masih berhadapan dengan kekangan dalam mencapai hasil yang tinggi dalam pengeluaran. Pada masa ini, terdapat kebergantungan kepada bahan kimia pertanian dalam menangani serangga perosak dan rumpai dalam pengeluaran padi. Objektifumum kajian adalah untuk membangunkan indeks kelestarian pertanian untuk petani padi. Objektif khusus adalah (i) untuk menentukan amalan semasa pengeluaran ini, (ii) mewujudkan indeks kelestarian pengeluaran beras, dan (iii) untuk menentukan faktor yang mempengaruhi amalan kelestarian petani padi. Kajian ini dijalankan di kawasan MADA Semenanjung Malaysia.

Data dari seramai empat ratus dua orang petani yang dipilih secara rawak di MADA telah dikutip melalui soal selidik yang berstruktur. Wawancara juga dijalankan untuk mendapatkan maklum balas mengenai pelbagai amalan pertanian. Data yang dikumpul terbahagi kepada ciri demografi, amalan pengeluaran pertanian dan rasional petani dalam mengawal serangan (i) serangga, penyakit dan rumpai, dan (ii) proses pembajaan yang dilakukan oleh petani MADA padi. Data tentang impak kelestarian dan kesannya kepada alam sekitar, amalan ekonomi dan amalan sosial petani juga dikaji semasa pengutipan data.

Statistik deskriptif digunakan untuk menerangkan amalan pengeluaran semasa bagi petani di kawasan kajian manakala indeks kelestarian mengikut skor diujudkan mengikut amalan pertanian petani. Kaedah OLS diaplikasi dalam penentuan faktor yang mempengaruhi amalan kelestarian pertanian.

Skor Indeks keseluruhan Kelestarian Pertanian untuk 402 petani adalah di antara 30.38 ke 76.04 (daripada jumlah 100), dengan nilai purata 49. Angkubah umur, tahap pendidikan, saiz ladang dan latihan IPM adalah bertalian positif (signifikan) manakala pekerjaan utama dan umur kuasa ganda dua adalah bertalian secara negatif (signifikan) kepada tahap kelestarian petani manakala kepada petani tahap kemampanan tahap. Keputusan empirikal analisis regresi berganda menunjukkan terdapat korelasi yang signifikan (R = 0.902) di antara faktor yang mempengaruhi kelestarian saperti yang diramalkan mengikut model regresi.

Kesimpulan kajian menunjukkan aktiviti pengeluaran beras adalah sangat lestari. Strategi memotivasi petani untuk dalam mengurangkan penggunaan input kimia dan menerima pakai amalan lestari amat menyakinkan dalam pengeluaran padi di MADA.

ACKNOWLEDGEMENTS

With a grateful and a profound gratitude to God almighty that have made it possible for me to scaled through the seemingly hard times.

My deepest appreciation goes to my principle academic advisor and supervisor, Professor Datuk Dr. Mad Nasir Shamsudin, Deputy vice Chancellor (Academic and international), for accepting me as his research student. His patience, tireless support, willingness to help and encouragement, kindness and guidance throughout the research and during the preparation of the thesis saw me through my program. My profound gratitude also goes to the members of my supervisory committee, Dr. Alias Radam and Dr. Ismail Abd. Latif for their constructive discussions, encouragements, suggestions and great advises in the course of this project.

My gratitude goes to Mr Fasoranti Ifeolu, for his available guidance and his invaluable assistance rendered when needed during my study here in Malaysia. I really appreciate your entire care sir. Special thanks to a senior colleague Dr. Adeolu Richard Adesiji, a big brother indeed that stood by me throughout this study.

Many thanks to my invaluable siblings: Barr. Elizabeth Oluwafisayomi Sapara, Arc. Olayemi O. Ajidasile, Engr. Emmanuel Olusegun Ajidasile and Mr Israel Oluwabukunayomi Ajidasile. Thanks for your prayers and support. I love you guys.

I also wish to express my sincere gratitude to my sweetheart, Oluwaseun Akintunde Davis, for His affection, prayers and encouragement. You are a gift sent from God. I also wish to say thank you to everyone who also play a significant role to the success of my work; special thanks to all my friends Charity ifunaya Onuwa, Carolinda Bosire, Femi Durojaiye, Henry Chibuike and Henry Egwuma, Abiso Buramo, and many more I couldn’t list here.

I would like to thank the ‘Dream Centre Online Church’ and RCCG, The Lord Chapel Parish, Malaysia Province I; you are truly a wonderful family to be associated with.

Lastly and most importantly, I once again give thanks to God Almighty for making everything possible and in whom I live and have my being.

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

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- the research conducted and the writing of this thesis was under our supervision;
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LIST OF ABBREVIATIONS

ASI	Agricultural sustainability index
BPH	Brown Planthopper
FAO	Food and Agriculture Organization of the United Nations
FSI	Farmer sustainability index
GAS	Golden Apple Snail
IOF	Inorganic Fertilizer
IPM	Integrated Pest management
LSD	Livestock Manure
LCA	Life Cycle assessment
MADA	Muda Agriculture Development Authority
MARDI	Malaysian Agricultural Research and Development Institute
MP	Malaysian Plans
MT	Metric Tonnes
NAP	National Agricultural Policy
NEP	New Agricultural Policy
OOF	Other Organic Fertilizer
SD	Sustainable Development
SYI	Sustainable Yield Index
USDA	United State Development of Agriculture
WPH	White Planthopper

CHAPTER ONE

INTRODUCTION

1.1 Sustainable Agricultural Development

With the recent growing concern about future food production and changing climatic conditions, the quest for awareness of sustainability has increased around the globe. As a result of this, agricultural production has become the top most international agenda. This is intended to address the growing global issues that deals with resource degradation, deforestation and ozone layer deflection (Zinck & Farshad, 1995). Until World War II, agricultural production throughout the world inclusive Malaysia involved cultivation of more parcel of land. But in the last 50years, However, in recent decades, available lands for faming activities has declined rapidly due to depletion of soil nutrient and increase in human population (Siwar and Hossain, 2001).

Similarly, the prevailing concern over environmental degradation and poor yields has pinpointed sustainability issues to be paramount. The fight for food security and safety of the agricultural products is necessary for sustainable production systems and management of the natural resources (land, biodiversity, and water) upon which human race depends. The tremendous decline in the availability of fertility land for farming activities has resulted into decrease in nutrient value of the soil. This notwithstanding, is associated with increase in conventional farming practices of farmers and the increase in human population (Siwar and Hossain,2001). However, the active use of biochemical fertilizers to boost production has also greatly increase environment pollution, degradation and reduction of natural and non-renewable resources (Power, 1996; Salleh, 2007).

The advent of the green revolution (1950's to 1960's) was marked by extensive usage of agrochemicals, which contributed to increase in food production. However, this development brought associated undesirable consequence, which has resulted into notable depletion of soil fertility over the years. Thus, it is viewed as a mixed blessing to mankind.

In addition, continuous use of agrochemicals has made the soil highly chemical fertilizer driven, decline in soil beneficial microbes and earthworms that contributes naturally to increase in soil fertility. It has also increased economic stress on farmers, as they need huge amount of these chemicals yearly to sustain productivity and soil fertility. To crown it, agrochemical has posed adverse effects on agricultural environments (soil, flora, fauna and the water bodies in the farms), farmers' health and the society consuming the chemically grown food (Sinha, 2009; UNEP-DTIE, 1999).

The notorious use of range of pesticides to enhance productivity has led to the development of biological resistance in some species of pests and disease causing organisms. Consequently, studies have shown that there are some indicative amounts of ‘residual pesticides’ polluting foodstuffs even long after they are taken away from the farms for human consumption (Bhatanagar, 1993; Rao, 1993).

The concept of sustainable development and its relationship with agriculture has been a constant research in the past years, various works have been carried out by different researchers to determine what is sustainable or not. The essence of this is to carefully combine biological and technological inputs. The huge emphasises are on cost of production, ecological stability, sustain production and target on restoring consumer confidence in product consume and producer’s confidence in the method of production. Although the purpose was to link poverty alleviation to ecological and natural resource management but it ended has an agreement to meet the need for economic growth without damaging the natural resources (Ciegis *et al*, 2009). It is not only limited to environmental issues (in agriculture, it is associated with the natural resource use and its impacts on the environment) but much more into how to maintain the environment economic and socio-political of the people (Chuen-Khee, March 2009).

1.1.1 General Sustainable Development

Although the concept of sustainable development is a well-defined one but the exact meaning and definition has caused strong debate (Ciegis *et al*, 2009). Sustainable development is described as the development that continues by the World Bank in 1992 (World Development Report, 1992). Rio de Janeiro expressed sustainable development as a long term uninterrupted development of people for the satisfaction of the present and future needs through sound use and replacement of natural resources, conserving the Earth for upcoming generation (Rio Declaration on Environment and Development, 1992).

According to Goodland and Ledec (1987), sustainable development involves the development of economics, enhancing the economic and the social welfare of the people at present without endangering the potential for gaining such future benefits. Pirages (1977), clearly expressed that sustainable development is the same as economic growth and this can be sustained by the natural and social environment. Sustainable development can be described as the means of economic development and physical changes that help in widening the human potentials (possibilities). And this is influenced by the power of knowledge which is best achieved through sustainable and balanced development of human possibilities and the ability to be accountable for oneself, the society and the upcoming generation (Petkevi i t Svirskait , 2001). However, Weitzman (1997), noted that sustainability is the standard for determining future consumption.

Munasinghe (1994), described sustainable development as a means of expanding ‘the spectrum of alternatives allowing individuals and communities’ to achieve their goals and capacity for development and simultaneously preserving the regeneration ability in economic, social, and ecological approaches. But the general concepts of sustainability development cover 3 basic components: ecological, economic and social developments that are related and interdependent on each other. The definition given by Brundtland Commission (1987) combined all aspects of the concept under research and it does describe the idea of sustainability best. The Brundtland Commission (1987) describes sustainable development as growth that meets the needs of the present generation without compromising the ability of future generations to meet their own needs (WCED, 1987). It contains within it two key concepts:

> the concept of 'needs', specially the vital needs of the world's poor, to which overriding priority should be given; and
> the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs .

Regardless of the general acknowledgement of sustainable development and the need for merging the 3 pillars together, the concepts still remains indefinable because it involves the way of thinking as well as farming system.

1.1.2 Sustainable Agricultural Development

Hill and MacRae (1988) defined sustainable agriculture as an alternative to traditional agriculture practices. These alternative practices involved the use of on-farm or locally accessible resources, moderate usage of chemical fertilizers and insecticides, increased or enlarged crop rotations and organic materials to improve soil qualities, with different combination/ blends of varying crop and animal species at a reduced stocking rates (Hansen, 1996).

> In 2013, sustainable agricultural production system was defined to involve those approaches to food production that ensures constant increases in productivity without compromising the chances of future generations to provide for themselves. It involves production practices that ensure environmental conservation and no or minimal disturbance to the natural eco support system, hence protects the potentials of the natural regeneration of the flora and fauna Nwaiwu, *et al*., (2013, p 2).

Hansen (1996) defined agricultural sustainability as an approach that is useful for prompting changes and for providing the means for agricultural improvement. According to him, agricultural sustainability entails adequate consideration to practices that maintain the soil health (such practices like soil fertility management and soil erosion control) and plant protection (such as insect control, disease and weed control). He does by concluding that these will not only improve the soil health and plant protection but also social sustainability. Amekawa (2010) noted that the resulting decline in pesticide use, will improve worker safety for producers and also food protection for consumers. The heavily use of chemical fertilizers in industrial agriculture are found to be connected and/or responsible for the high incidence of cancer risk in consumers and also in the workers (Horrigan *et al*., 2002), not only this, it has a strong effect on the environment (Forcella, 1988).

Sustainable development as related to agriculture can also be defined as an act of replacing resources produced on farm for purchased synthetic fertilizers and agricultural chemicals (insecticides, fungicides, and herbicides), and other mechanisms to arrive at the most effective and competent use of the natural resources and people in the short run and long run (Shamsudin *et al*., 1994). The on-farm resources identified involved combined pest management practices for biological control of insects; crop rotations, intercropping, and relay cropping to boost soil fertility, and maximize use of space and time; livestock waste, crop residues and green manures to enhance soil fertility; nitrogen fixing legumes for collecting and recycling nitrogen from the air; reserving and recycling of minerals from the soil; water availability to crop through improve soil moisture retention; use of varieties that are tolerant to insects and diseases; modification of sowing (planting) dates and other cultural practices and farm family management and labour (Shamsudin *et al*., 1994).

The Food, Agriculture, Conservation and Trade Act (1990), defined agriculture sustainability as a farming integration system where plant and animal production are cultivated on the same farm enterprise for the purpose of meeting the food and fibre of the populace. This is done with the objectives of ensuring long-term sustainability of the environment and natural resource. The correct or applicable natural biological cycles and control depend on the most effective use of non-renewable resources, and on-farm resources that can sustain the economic viability of the farm business and improve the quality of life of both the farmers and the society (United States Congress, 1990). From this definition, there are emphasizes on output, environmental quality/ standard, competent usage of the non-renewable resources, economic viability and quality of life in both for short run and long run effect.

> According to 1992 Earth Summit in Rio de Janeiro, the UN food and FAO definition of sustainable agricultural development, it is the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such development in the agriculture conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable (FAO, 1989).

However, with present food production practices which involved the use of biochemical fertilizers as a means to boost production has greatly increase environment pollution, degradation and reduction of natural and non-renewable resources (Power, 1996). These depletion is due to the increase in the conventional farming practices of farmers and these practices fluctuate from paddy farm to another and from one country to another country (Siwar and Hossain,2001).

Most of the arable land was found to be unsuitable for agricultural production due to land compaction. The land degradation especially the deterioration of fertile soils for agricultural production has become a major concern facing the world as efforts is on the increase on how to feed the growing population (McMichael, 1993). The heavy reliance on machinery like tractors and harvesters has destroyed the clay-pen of the soil hence leading to the problem of Land compaction (Pretty, 1995), and destruction of the soil structure and killing beneficial organism that are of great value to the soil food web. Land compacting can make the soil to be susceptible to erosion, through this a lot of nutrient are lost from the soil (Horrigan *et al*., 2002). Besides direct seeding, 80% of the work in many paddy plantations is done by mechanized and the Local paddy farmers are yet to finally understand the urgency on how to safe guard and use agriculture resources on a sustainable basis (Pretty, 1995)

Sustainable agriculture is a multifaceted complex concept and the precise measurement is complicated as it is location-specific and dynamic rather than static concept in nature (Ikerd, 1993). But the precise measurement is not possible when specific or detailed indicators are carefully chosen with specific consideration given to selected trends to determine whether they show some tendency to fluctuate (steady) either up or down (Pretty, 1995). These indicators are those attributes in the system that is quantifiable and measurable. The suggested indicators given by USDA to evaluate agricultural sustainability at farm and regional levels are based on these six measurable variables: yield, frequency of crop failure, profit, organic carbon, soil depth and permanent ground cover (Gomez *et al*., 1996 ; Siwar *et al*., 2009). This interest in sustainability was due to environmental crises and health hazards arising as result of an adverse side effect of conventional farming and this called for immediate response. The conventional farming is characterized by large capital investment, large scale, highly mechanized systems with single crop being cultivated and large amount of artificial fertilizers and chemical pesticides are used (Hill & MacRae, 1988; Schaller, 1993).

Young *et al*. (1991) in their study disagreed with the level of quality used as indicators or criteria for categorizing whether farmers are conventional or sustainable in the agricultural production. From their work, we are made to understand that previous classifications still had similar relationship to the four-farm/farmer characteristics (such as the number of acres farmed, net income per acre, views on farm policy, and the number of organizational memberships). But Harrington (1995) classified each definition into types of agro-ecology, ethics and sustainable growth.

But different studies (Bird *et al*., 1995; Drost *et al*., 1997; Menanteau-Horta *et al*., 1991; Taylor *et al*.,1989; Taylor *et al*., 1993) shown that majority of farmers have problems with weed controls and the means of controlling them ranges from physical means (involving hoeing, mowing, machine tillage, etc.), cultural means of weed controls with the use of practices that can improve crop competitiveness with weeds (crop rotation, crop interference, timing of planting), biological control techniques involving the use of biotic (organic) organism to control weeds and chemical control entailed the use of both organic and inorganic compound) (Aldrich & Kremer, 1997).

Separate studies conducted by Benbi *et al*., (1998) and Yaduvanshi (2003), reported that the inclusion of organic materials with the use of chemical fertilizers will improve physical soil properties, build up soil fertility and improve crop yield. The increased use of agro-industrial waste, municipal wastes, and animal manure can be of help in reducing over dependence on mineral nitrogen fertilizers. It is important to note that these organic materials are easily accessible due to the fact that they are local availability as a source of nutrients and means to improve soil properties or qualities. Different researchers (De Jager *et al*., 2001; Palm *et al*., 2001; Soumare *et al*., 2003; Stamatiadis *et al*., 1999) have found out in their work that the input of organic materials particularly under low input agricultural system has the ability to improve the fertility and the quality of the soil.

1.2 Rice Production in MADA

1.2.1 General Rice Production in Malaysia

Rice is one of the most essential food crops in the world (more than half of the world population IRRI, 2006) and ranks second in terms of area and production. It is the primary food for about 50 per cent of the population in Asia, where 90 per cent world's rice is grown and consumed. The Asian's, food security depends mostly on the irrigated rice fields, which account for more than 75 per cent of the total rice produced (Virk *et al.*, 2004). In Asia, 17 million ha of irrigated rice area may suffer physical water scarcity and 22 million ha may have economic water scarcity by 2025 (Devi & Ponnarasi, 2009) since rice is a proliferate user of water and it can consume half of all fresh water resources.

In Malaysia, rice is a traditional staple food crop. Apart from being the staple food of the country, the industry is the main livelihood to nearly 297, 600 farmers where about 40 percent (116,000) of them are full time rice farmers. Though the population of the farmers is slightly more than one percent of the country's total population in 2001,where majority of the rice farmers are native Malays (Bumiputra) and they represents a politically meaningful or sizable number in the national policy with preference to them particularly in the Peninsula or Mainland (Daño & Samonte, 2005). Paddy production accounted for only 3 percent of the agricultural output and it is mainly associated with rural area where it is cultivated by small holder with farms size of about 1.06 hectare (Ibrahim & Mook). Since rice is considered as the main staple food in Malaysia, self-sufficiency level has been driven on paddy and rice production.

The paddy area in Malaysia is about 598,483 hectares in 1993 covering granaries (irrigated) and non-granaries (rain-fed) areas. Out of the granaries area, 290,000 hectares are in Peninsula Malaysia, 17000 hectares in Sabah and 15000 hectares in Sarawak. But 217000 hectares of the irrigated area in Peninsular Malaysia is classified as the leading granary area while 28,000 hectares are classified as mini-granary area. These granaries areas in Peninsular Malaysia are concentrated mainly in eight rice-producing areas and it accounts for 70 percent of the total cultivated paddy area of the country. About 48 percent (322,000) of the paddy areas are provided with massive irrigation and drainage facilities while the remaining is rain-fed area (Daño & Samonte, 2005; Ibrahim & Mook).

Because of the social, political and economic importance of paddy production, the government heavily regulates the paddy industry. The country paddy production is about 2 million tons annually; this improved or grew from 2,044,604 tons in 1980 to 2,127,271 tons in 1995. From the table 1.2 below, we can see that there was a slipped in production in 1997 to 2,119,615 tons, later increased to 2,140,904 tons in 2000 but 2001, 2006, 2010, paddy production was found to have fluctuated slightly below their previous years. Contrarily to the declining trend in the harvesting from 716,873 hectares in 1980 to 672,787 hectares, the average annual yield has shown a reasonable increased from 2,852 tons/ hectare in 1980 to 3,162 tons/ hectare in 1995 (Daño & Samonte, 2005; Sharif, 2009). The industry has been faced with various shifting from traditional ways which depends on the natural soil's fertility to practices that relied on high levels of chemical usage and energy saving production (conventional practices)(Mohamed *et al*; 2013).

Due to this decreasing level of rice sufficiency, the government intervention was to ensure food security through the rice sufficiency policy. This policy was not only met to ensure food sufficiency but also to increase the farmers' income and to maintain a long-standing rice supplies for the populace. As a result of the approach (scheme) introduced by the government in the Third to the Seventh Malaysian Plans (3MP-7MP), which aimed at empowering the agricultural sector, there was a shift in the direction of production of high value crops and industrialization at the detriment of rice paddy production. This resulted into continuous decreased in paddy production from 1996 to 1998 while the government bailed out was through importation of rice to meet the needs to the customers (Daño & Samonte, 2005).

Table 1.1. Principal statistics of paddy and rice by all Seasons, 1980-2011, Malaysia

Year	Planted area	Average yield (Hectare age)	Paddy production
	Hectares	Kilogramme/ hectares	Tonnes
1980	716,873	2,852	2,044,604
1981	710,789	2,842	2,019,900
1982	682,070	2,762	1,883,604
1983	665,813	2,605	1,734,325
1984	630,833	2,491	1,571,674
1985	656,375	2,975	1,952,914
1986	650,875	2,640	1,718,215
1987	658,954	2,469	1,626,699
1988	671,755	2,525	1,696,239
1989	664,137	2,625	1,743,444
1990	680,647	2,769	1,884,984
1991	683,640	2,818	1,926,354
1992	672,753	2,992	2,012,732
1993	693,434	3,035	2,104,447
1994	698,624	3,061	2,138,788
1995	672,787	3,162	2,127,271
1996	685,468	3,251	2,228,489
1997	690,975	3,068	2,119,615
1998	674,404	2,883	1,994,240
1999	692,389	2,941	2,036,641
2000	698,702	3,064	2,140,904
2001	673,634	3,110	2,094,995
2002	678,544	3,238	2,197,351
2003	671,820	3,360	2,257,037
2004	676,310	3,434	2,291,353
2005	666,781	3,471	2,314,378
2006	676,111	3,236	2,187,519
2007	656,602	3,514	2,375,604
2008	656,602	3,584	2,353,032
2009	674,928	3,720	2,511,043
2010	677,884	3,636	2,464,831
2011	683,677	3,898	2,665,100

Source: Department of Agriculture Malaysia
http://www.statistics.gov.my/portal/download_Economics/files/DATA_SERIES/2011/pdf/08Padi.pdf

In other to boost rice production, the government implemented various programs such as fertilizer and investment subsidies and a guaranteed minimum domestic price. Although, these support measures for rice has incurred a substantial budgetary cost to the Malaysian government and it was estimated in 2004 at 187.7million Malaysian ringgits (US $57million). The guaranteed minimum price is implemented through

BERNAS a trading company who is responsible to buys paddy rice from farmers at 65ringgits per 100 kilograms (US $18) (Hoh, 2006).

To ensure continuity in rice production and sufficiency, the government designated eight granary areas namely; the Muda Agriculture Development Authority (MADA), Kemubu Agriculture Development Authority (KADA), Barat Laut Selangor, Besut, Kerian/ Sg. Manik, SeberangPrai, Seberang Perak and Kemubu/ Semerak of various sizes and productivity (Tan Siew Hoy, 1987). Muda in Kedah is the largest of the eight granary areas with 98 860 ha, Kemubu in Kelatan is the second largest with 32 400 ha, Kerian in Perak covered 24 010 ha, Projek Barat Laut Selangor (PBLS) covered 19 920 ha of land, Seberang Perak in Perak covered 9510 ha, Sungai Manik in Perak covered a large area of 6510 ha, Besut covered 5100 ha of land area in Terengganu and SeberangPerai in Penang covered 1300 ha.

Rice produced are grown mainly in two seasons within a year, the main season is between October to March while the off season is normally between April to September (Karim *et al*., 2004). The farmers depend on irrigation (the irrigated water is collected from the canal) during the off season due to the inadequate rainfall or lack of sufficient rain but during the main season there is sufficient water requirement for the plant. The method of planting in rice cultivation is direct seedling and transplanting (Chan & Cho (2012); Angin, 2004; Tabbal *et al*., 2002; Ho, 1996).

The government programs, supports and interventions are mainly in these eight designated areas. In 1985, 64.3 percent of the national production (35.7 percent) was from the granary areas, the remaining 35.7 percent was the non- granary area. Also, in 1990 the granary area is responsible for 68.8 percent of the total production (31.2 percent). The total production in 1985 increased from 1.74 million tons to 2.13million tons in 1995, the mean yield per hectare grew from 2.7 tons to 3.2 tons from 1985 to 1995 (Daño & Samonte, 2005).

Table 1.2. Rice productivity among the various rice growing areas in the peninsular of Malaysia.

GRANARY AREA	AREA (HA)	% AREA	CONTRIBUTION TO NATIONAL PRODUCTION (METRIC TONNE AND %) 2008	%	2009	%	2010[A]	%
MADA	**96,558**	**23.22**	**887,992**	**37.74**	**976,192**	**38.88**	**912,321**	**37.01**
KADA	32,167	7.74	179,048	7.61	209,950	8.36	201,135	8.16
IADA K.S MANIK	27,829	6.69	169,753	7.21	187,117	7.45	184,563	7.08
IADA BL S'GOR	18,814	4.52	174,247	7.41	202,633	8.07	210,292	8.53
IADA P.PINANG	10,305	2.48	98,436	4.18	107,285	4.27	115,189	4.67
IADA SBG PERAK	8,529	2.05	62,076	2.64	70,294	2.80	70,814	2.84
IADA KETARA	5,156	1.24	46,097	1.96	49,082	1.95	52,711	2.14
IADA K.SEMERAK	5,220	1.26	14,757	0.63	16,853	0.67	20,550	0.83
TOTAL GRANARY	**204,578**	**49.20**	**1,632,406**	**69.38**	**1,819,206**	**72.46**	**1,757,575**	**71.31**
TOTAL NON-GRANARY	**211,213**	**50.80**	**720,626**	**30.63**	**691,637**	**27.54**	**707,256**	**28.69**

Source: Early Reports Paddy Production Survey Study off Season 2010 Issue of secretariat National Survey of Rice Production, Department of Agriculture, accountants.[A] Preliminary Data .http://www.apip-apec.com/files/Malaysia_FINAL-Malaysia-COUNTRY_REPORT-OK_DCCW.pdf

1.2.2 Self Sufficiency Level in Rice Production

Food self-sufficiency in Malaysia is decreasing yearly due to the weakness of the agricultural sector of the country in producing large cash crops and little food. The Malaysia government view rice as an important crop in the food sub-sector and their self-sufficiency programs has undoubtedly focused on rice.

During the 1960s (1st Malaysian Plan -1966-1970) when imported rice from the exporting countries becomes unstable, the government was compelled to ensure food security through the Rice self-sufficiency policy. The objective of ensuring food sufficiency was not exclusively confined to the policy but also directed with respect to improve the farmers' income and ensuring steady supplies for customers. Also, the government made promises to increasing the economic level of the rice farmers whom majority is Malays. During this period, there was an increase of 11.9% a year during the 1MP in the local rice production; the National Paddy and Rice Authority was established to organize or coordinate the different aspects of paddy and rice (production, processing and marketing). During the 1MP, the FAMA (Federal Agriculture and Marketing Authority) played an important role in regulatory plans in the principal paddy states of west Malaysia and also initiated paddy trading in Selangor (TanjungKarang), Kedah, Kelantan and Terengganu. The Agricultural Bank was established to organized and to strengthened public sector credit programmes for agriculture. In 1966, FELCRA (Federal Land and Consolidation Authority) was established to alienate develop land that is inactive for agricultural purposes (Indrani, 2001).

The 2nd Malaysia plan was implemented between 1970- 1975 and this contributed to the growth of the agricultural sector by 5.9%. Even with the creation of 150,000 new jobs, the agricultural sector still recorded a decline in the total employment due to the growth in the other sectors of the economy. Although, there is an increase in food production within the country due to the government initiatives for food self-sufficiency but for paddy, the 90 percent self-sufficiency was increased to 100 percent. The provision and improvement of irrigation facilities, the increase of yields through varietal improvement and provision of incentives such as Guaranteed Minimum Price (this is a ceiling price set by government for paddy) and the urea subsidy scheme are the several measures adopted during this period. This brought about an increase of about 87% in domestic production of paddy from 1.6 million tons (1970) to 2 million tons (1975). Farmers were also given some production incentives (price incentives and input subsidies) and facilities through the Agriculture Department. The MUDA and Kemubu irrigation schemes were also implemented to increase production of paddy (Indrani, 2001).

The 3rd Malaysia Plan (3MP) launches the New Economic Policy (NEP), which gives precedence priority to agricultural sectors, with the objectives of improving income levels and employment opportunities in the sector. These objectives were achieved through the provision of inputs to large numbers of small farmers so that they could raise their yields, and therefore, incomes (Indrani, 2001). The government invested RM 2,744.65 million to open up lands for agricultural use, recover idle lands and to build drainage for agriculture and food crops (especially rice production). This government investment brought about an increase in paddy production from 1.6 million tons (1970) to 1.9 million in 1980 and yield per hectare increased from 1,055 gantang to 1,260 gantang while acreage under paddy increased from 533,400 hectares to 595,600 hectares, of which 56% was under double-cropping. There was an increase from 82 percent to 92 percent in rice self-sufficiency (Daño & Samonte, 2005; Indrani, 2001).

The 4th Malaysia Plan main (4MP: 1980-1985) objective was to increase income by improving productivity and creating employment opportunities but the NEP is still responsible for the enhancement of the agricultural sector. In 1985, paddy production record 1.1 percent increase in production from 2,040,200 tons (1980) to 2,258,000 million tons. This accounted for 73.6% in rice self-sufficiency has against 92 percent in 1980. This decline was due to the change in weather condition, instabilities in yields and crop intensities. Due to the drop in production, the government imported RM 257.10 million worth of paddy to meet the supply and demand gap of 426,000 tons. With the increase in importation, the government came out with the First National Agricultural Policy (NAP1) in 1984. The main objective of the NAP1 was maximization of income from agriculture through efficient utilization of the country's resources to increase production, efficiency and competitiveness in the development of new resources. However, importation of food increased with decline in food production. Fees are attached to planting materials and other inputs that had been made available for free by the government, thereby leading to an increase in cost of production for farmers and drop in production. This was the commencement of high volume of rice importation into the country as result of the self-sufficiency level of rice at its lowest when compared to previous years (Indrani, 2001).

During the 5th Malaysia Plan (5MP: 1986-1990), efforts were taken to revive and reform the agricultural sector through the urbanization of the rural areas. The major thrusts of 5MP were towards modernizing and commercializing the smallholder sub-sector; rationalize the extent of government involvement and increase private sector participation in agriculture. The agriculture sector was increased by 4.6% contributing 18.7% to the total GDP, although, NAP1 was still being implemented. Increase in paddy production was 1.03% in 1990 (1,271,000 tons) with self-sufficiency level of 79.4% (this was increase just below the targeted 80% by NAP1); this was due to the labour deficiency, low returns, poor management and occasional droughts in the non-granary areas of the northern peninsular. Even after 5 years implementation of NAP1, Malaysia food importation were still on the increased and the percentage of self-sufficiency in rice were unobtainable even with NAP1 special privileges being given to paddy production. Furthermore, it was clearly stated under NAP1 that production of agricultural commodities with the exception of rice would be centred on economic returns. This seems to give priority to cash crops while food crops were relegated, giving room for high cost of production with low returns (Indrani, 2001).

In 6th Malaysia Plan (6MP; 1991-1995), attention was to ensure that agriculture remained competitive in the international market, therefore economically feasible or viable. For products that were not competitive, research and development (R&D) was to be emphasized towards enhancing their competitiveness. Emphasize of the NAP1 on agricultural sector was stressed on being competitive, market-driven and commercialization. Focus was basically on large-scale production and rural industrialization with self-sufficiency in food production was never encouraged. The Second National Agriculture Policy (NAP2: 1992-2010) was introduced and executed with emphasizes on policy that encourages research and development in agricultural sector towards commercialization that is market driven. NAP2 stressed that the agriculture sector should be market-led, commercialized, efficient and competitive. The strategies of the NAP2 are focused on large-scale production, rural industrialization and commercialization. Although, import substitution for food crops was stressed under NAP2, importation was on the increase with food production remaining relatively low when compared to the production of cash crops (Indrani, 2001).

Table 1.3. Food production sector in 1995

	Paddy	Livestock	Vegetables	Fisheries
Production (tons)	1,373,000	1,400,100	609,600	764,500
Land-used (ha)	670,000	-	-	-
Self-sufficiency level	76.3%		71.6%	
Import (RM Million)	356.1	1,473.2	683.4	762.4

Source: Ministry of Agriculture

The 7th Malaysia Plan (7MP: 1996-2000) saw a reduction in the role of agriculture in the country's economy and a slow growth in the food sector. It reflected an agriculture that is moving towards large-scale production particularly in the production of food commodities and high-value produce by reorienting production methods to a more driven agricultural economy and free market trade as a result of Malaysia's accession to the World Trade Organization (WTO). This shift in policy towards the production of high value crops and industrialization resulted in the continuous decrease in annual rice paddy production from 1996 to 1998, while rice import bill increased exceptionally from RM 527.52 million (1996) to RM 701.31 in 1997 and RM 910.52 in 1998.

Table 1.4. Domestic self- sufficiency level for paddy in Malaysia (2012)

Plan Period	Self-Sufficiency level (%)
First Malaysia Plan (1966-70)	80.0
Second Malaysia Plan (1971-75)	87.0
Third Malaysia Plan (1976-80)	92.0
Fourth Malaysia Plan (1981-85)	73.6
Fifth Malaysia Plan (1986-90)	79.4
Sixth Malaysia Plan (1991-1995)	76.3
Seventh Malaysia Plan (1996-2000)	71.0
Eight Malaysia Plan - (2001-2005)	71.0
Ninth Malaysia plan - (2006-2010)	72.0
National food security policy (2008)	72.0
New economic model (2010)	Target 85 by 2020
National agro-food policy (2011-2020)	Target 70 by 2012

Source: MOA 2012; (Fatimah et al., 2010)
http://www.maxwellsci.com/print/rjaset/v7-711-722.pdf

It was during 7MP that the NAP2 was reviewed and NAP3 was introduced and implemented in 1998. The objectives of the NAP3 are to enhance food security, increase productivity and competitiveness, create new source of growth, deepen linkages with other sectors and conserve and utilize natural resources on a sustainable basis. In spite of the move towards agro-based agriculture and the focus on high or important-valve crops, the NAP3 clearly specified that paddy production would be maintained and targeted at a minimum self-sufficiency of 65 percent in respect of rice being a staple and the basis of culture and tradition of the Bumiputra (Malays).

In 1998 to 2010, the Third National Agricultural Policy (NAP3) was declared in the middle of the financial crisis of 1997-1998 to give agriculture a renewed role in meeting the growing concern in food security. The prevailing goal of the NAP3 is the maximization of income by means of optimal use of resources. It employs strategic line of action to agricultural development through the means of agro-forestry (integration of agriculture and forestry development) and product-based approach (this has to do with commodity development that are based on market demand and preferences) (Siwar and Hossain, 2001).

Currently in the country, paddy production is faced with some sustainable issues (Siwar and Hossain, 2001). The land use for food crop (especially paddy) by and large is showing a deteriorating trend and this has an implication for food security and self-sufficiency. The government decision to limit paddy production to the granary areas is a limiting factor in the expansion of the irrigated areas. The holding back of water for the urban supplies might lead to the inadequate dry season flow into the sea thereby resulting into the problem of salt-water intrusion (Siwar and Hossain, 2001).

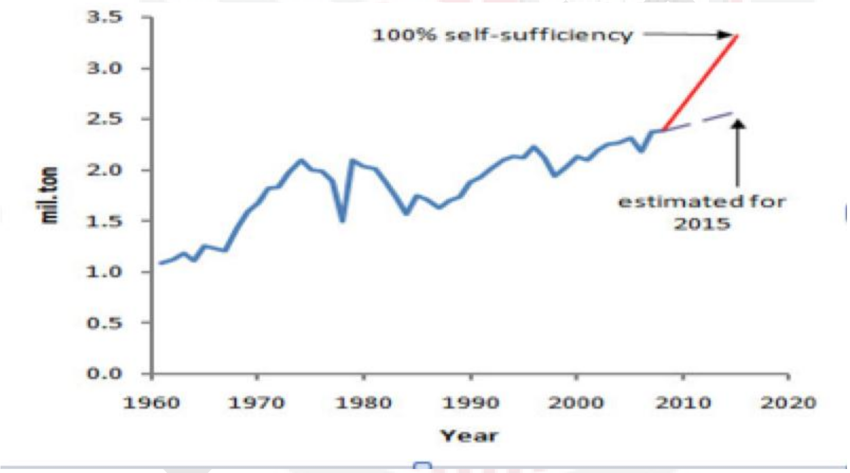

Figure 1.1. Malaysia's Rice Production
Source:http://christopherteh.com/blog/wp-content/uploads/2010/07/msia_rice_yield.jpg

1.2.3 Rice Production in MADA

MADA (Muda Agricultural Development Authority) is a specialized institution of the Malaysian government to improve paddy production for the Malaysian community. It is considered the rice bowl of Malaysia because about 40 of the total rice production in Malaysia comes from the area (MADA, 2010). It is the largest and the most vital granary area in Peninsular Malaysia. 63,000 farm families operate the scheme and the covered area is about 96,000 hectares of paddy land.

MADA is a drought prone area and the major water supply is from 4 main sources, namely direct rainfall on rice fields, Dam release, uncontrolled river flow and recycled drainage water. Despite the good irrigation infrastructure facilities, nearly 52% of the total water supplies for paddy production are still from rainfall. The reservoirs (and dams) provide about 30%, followed by rivers (13%) and recycled water (5%). This actual annual water supply from rain, uncontrolled flow and dam release is reported to be between 2.9 m and 4.1 m high (Tawang & Ahmad, 2003) and it is equal to at least 3,000 million cubic meters for the entire area.

The drastic change in rice cultivation in peninsular Malaysia, which involved directs seeding was the major crop establishment method replacing traditional, planting method. This adapt of direct seeding has gained momentum in the rice ecology since the 1980s and it has become the most important form of rice cultivation in Malaysia. There was a greater risk from insects and disease pathogen and this was due to the closed canopy and increased plant density of the rice crops (Chin, 1985). In addition to direct seeding, the grassy weeds and rice seeds germinate at the same time (together), thus allowing the grassy weeds to flourish and compete with rice crop.

Several programs have been implemented to improve pest management in rice production and many more research programs conducted under the guiding principle of integrated pest management (IPM), during which different control method were used. In some cases, farmers do not continue in the IPM practices even when the projects has been completed because they feel the practices are too tedious (the need to go to rice fields for frequent surveillance under IPM was considered as a burden by the old farmers) and/or financially non beneficial. And it could be as result of no significant increase in yield after practicing IPM even though there was reduction in chemical used (Normiyah & Chang, 1998).

MADA has taken positive steps, following MARDI's recommendations to encourage rice farmers to use selective insecticides such as buprofezin with low toxicity to mammals, fish, and natural enemies. The acceptance of buprofezin has been encouraging and it is use both alone. Traditionally, MADA farmers works on paddy planting in changing system, but due to the absence of labour and increase wage rate, majority of farmers changed to direct seeding system. Since 1980, direct seeding has become the major paddy planting practicing in MADA area. There are 3 main methods commonly practiced during direct seeding, namely: direct wet seeding, direct dry seeding and direct seeding in water.

a) Direct Wet Seeding

The paddy straw stubble is cut very close to the ground, disperse and leave for 2-5 days to be dry. The straws are totally burnt so it could destroy the weedy paddy seed and weed on the ground. This is followed by the first rotation (dry rotation), which is usually after 7-14 days after burning the straws. Second rotation (wet rotation) is done when the soil is overrun by water. After which, pretilachlor is applied to the stagnant water (height between 5-10 cm) and leave it for 10 days. Then, the paddy seed is scattered when the soil is flattened and in damp condition.

b) Direct Dry Seeding

Mostly, dry soil rotation is done in the first paddy-planting season, which is usually done in dry way. After the dry rotation, using cam tractor flattens the soil and sowing on the dry surface of the paddy field follows this. Another rotation is done to mix the seed with the soil. This method is to reduce the use of water.

c) Direct Seeding in Water

Also, the paddy straw stubble is cut very close to the ground, disperse and leave for 2-5 days to be dry. The straws are totally burnt so it could destroy the weedy paddy seed and weed on the ground. And this followed by the first rotation (dry rotation), which is done after 7 – 14 days of burning paddy straw. Application of glisofat or glufosinat weedicide is done to subdue weed growth especially weedy paddy after the first rotation. This is followed by the second rotation (wet rotation), after which pretilachlor poison is applied to stagnant water (5 – 10 cm) for 10 days. Sowing is done in water logging paddy field; this is to reduce the infestation of weedy paddy.

Other than direct dry seeding, planting method could also be used. This traditional planting method by hand is no longer in use but the Jentanam method. This method might increase the planting time and also determine the consistent paddy seed number that has been planted. In addition, this method would be able to facilitate the pest control and disease that occur in the paddy field.

1.3 Sustainability Issues in Rice Production

Paddy farming is an important agricultural production in MADA area and since any agricultural activities affects the environment, human health and even the social order, therefore, any effort to achieve sustainability must be set as a priority for attaining sustainable agriculture (Horrigan *et al*, 2002). As earlier stated that the concept of sustainability entails productivity, environment quality, efficient use of non-renewable resources, economic viability and quality of life, it is important to look at the sustainability issues in rice production under the three component of agricultural sustainability namely; ecological, economic and social (quality of life).

1.3.1 Environmental Issues

Paddy production in MADA is dominated by conventional methods of production. Currently, chemical control of weeds and pests has come to be the prevalent method of controlling weeds and pests. Active use and over-dependence of herbicides has become common production practice of majority of the farmers to boost their food production. These over dependence on the use of chemical control such as pesticides, herbicides and fertilizers for combating pest and insect attack, to improve productivity can lead to several environmental, human and economic problems (Normiyah & Chang, 1998).

Although, the goals of the farmers are to increase yield and to decrease the cost of production but these goals are not achieved due to their excessive use of expensive off farm inputs that causes environmental degradation (having lacking negative impacts on human health) (Bridges, 1994) and also promoting economic inefficient production system. Some of the agricultural commodities may have little amount of the herbicide residues, which might have a long-term effect on the human health. According to Jusoh et al., 1992 pesticides residues found in 34.5% of samples were more than maximum residual limit. Between 2001 and 2002, RM326 million and RM307 million values of agricultural chemicals were respectively used in Malaysia; among used are rodenticide (4%), fungicides (6%), insecticides (17%), and herbicides (73%). Several studies on pesticide residue in Malaysia reported that several chromic and health effects like leukaemia, non-Hodgkin's lymphona, neurological and haematological symptoms, and skin disease have been associated with drawn exposure to pesticides Sharif *et al.*, (2011); Andreotti *et al*., (2009); Jusoh *et al*., (1992); Blair & White (1985) and Hoar *et al*., (1986).

The changes in the traditional practice of farming and the increase use of chemicals led to the modification in the weed species across the area (Karim *et al*., 2004). The advent of direct- seeding causes the steady move from broad-leaved weed (prominently weed flora) to more grassy weeds (Itoh *et al*., 1996). These changes resulted into heavy use of chemicals. The use of broad spectrum herbicide causes weed resistance (Coble, 1994; Kim, 1996) and this restrain are due to heritable change in the chemical processes that support plants survival when treated with herbicides (Ismail *et al*., 2003).

Pests and diseases management still remains the crucial constraint in attaining high yield in paddy production in Malaysia, with about 85% of the rice farmers reporting that pests and diseases were their major problems. About 65% of these farmers needed extensive use of pesticides to control the problems (Normiyah *et al*. 1995 and Mohamed, *et al*; 1994).

Most of the farmers practiced early spraying and it is done during the first 40 days of crop formation against leaf feeders. The insecticide application is done as a result of perceived fear rather than the need for it and this has been the major cause of the secondary pest such as brown plant hopper (BPH) which was induced by early spraying (Heong *et al*., 1995; Normiyah & Chang, 1998).

The farmers are still involved in high seeding rate of 100kg ha^{-1} and these wasteful seeding rates are found to aggravate the lack of clean seeds and increase input cost. Although, many of the farmers are aware of the important of using clean seeds for its serve as an important component for weed control, but their availability and supply still remain a major problem to the rice farmers. Due to this inadequacy, many rice farmers retain some portion (quantity) of their harvest for seeds or buy from their neighbours (Normiyah & Chang, 1998).

The burning of paddy stalk after harvesting are still widely done by paddy farmers to facilitate land preparation, for controlling pest and disease on the field and to enhance the fertility level of the paddy land(Normiyah & Chang, 1998). And this burning is found to have a negative effects on both the environment and the socio-economy of the farmers (Rosmiza *et al*, 2012).

1.3.2 Social and Economic Issues

MADA region is among the poorest regions in the country, where the per capita income is only about two-thirds of that of the national income. As an agricultural-based area, most of the low-income population groups are directly related with economic activities in the agricultural sector. There is low farm productivity due to an uneconomic size of the farm (Tawang *et al*, 2002). The small-scale farmers have an average farm size of 3.3 hectares and less productivity of the farmers due to old age (average age of 51 years & above) Terano, *et al.* (2013 p 75). The average income for farmers is about RM1, 806/month, of which RM1, 267/month comes from paddy cultivation. The average monthly expenses were RM1, 575 monthly; this is an indication that the income for rice cultivation was unable to cover the farmers' monthly expenses (Mohd Rashid, 2013).

Although, MADA area contributed more to national rice production but the average yield is still @ 5 tonnes/ha/season, which was higher than the national average of 3.74 reported (MADA, 2010).

1.4 Problem Statement

Despite the good effort of Malaysian government towards positive growth in paddy production in MADA area, production is still facing challenges that are related to environment, social, economic, acceptance of technology, low density of infrastructure, etc. The depletion in the nutrient capacity of the soil, insignificant gain in productivity and the constant rise in production cost are some of the constraint faced by farmers in MADA area. And this calls for the urgency and direction towards agricultural sustainability.

Poor farm practices and managements are major problems in the paddy cultivation over the years. Paddy production in MADA is dominated by conventional methods. Currently, chemical control of weeds and pests has come to be the prevalent method of controlling weeds and pests. Most of the farmers rely heavily on pesticides and insecticides for combating pest and insect attack, and fertilizers to improve productivity. Most of the MADA farmers practiced early spraying, usually 40days of crop planting against pests attack. This is done on perceived fear rather than the real need for it against leaf feeders. This early season spray does not benefit paddy production but could lead to harmful environmental imbalance and also cause secondary brown plant hopper (BPH) problem.

The changes from the manual transplanting to direct seeding due to lack of labour and increased wage cost are contributing factors to the high incidence of weeds particularly the more aggressive grassy weeds. High incidence in chemical weeding is the most acceptable method among the paddy growers as it is found to be labour saving and cost effective. This excessive constant use of herbicide is responsible for problem of weed resistance. Although, the farmers are conscious of the health risk caused by pesticide application, but still treat it with less concern.

Also, burning of paddy straws is widely done by MADA farmers to facilitate land preparation, control pest and disease and in improving the fertility level of the paddy land, all these have negative impact on the environment and as well as the farmers' health.

1.5 Objectives of the Study

The general objective of this study is to develop agricultural sustainability index with reference to rice production. The specific objectives are:

i. To describe the present production practices

ii. To create sustainability index of rice production. Focus is on soil health (soil fertility management, soil erosion control and other related practices), plant protection (insects' control, disease control and other control practices) and socioeconomic of the farmers.

iii. To establish factors affecting the sustainability practices.

1.6 Scope and Limitation of the Study

This work will focus on the development of agricultural sustainability index of the rice farmers in MADA area in Malaysia. The study involved undertaking a field survey of the study area on the active use of chemical in the production practices of the farmers excluding the effects of heavy machinery. This work focuses on certain indicators that are suitable to achieve the goal of sustainable paddy production. Such indicators like soil health (soil fertility management and other related practices), plant protection (insects' control, disease control and other control practices) and socioeconomic of the farmers. The population totalled 402 respondents that are randomly selected from the four regions (Perlis, Kubang Pasu, Pendang, Kota Sarang Semut) in MADA area. Data required for the study were collected through structured questionnaire. To describe the present production practices of the farmers, descriptive analysis of IBM SPSS statistics 21 were used to achieve this. The sustainability index of the farmers was created by assigning values to practices of farmers using Excel workbook. The indicators in the index cover the three aspects of the sustainability. The environmental indicators include soil fertility management, pest and disease management and the farm management practices of the rice farmers. The economic indicators include crop diversity, land productivity, farm size. The social indicators include age of farmers, level of education, family size, use of credit, pluariactivity of the farmers. The study further establishes the factors affecting the sustainability practices of the farmers. But for this study, we only want to look at the effect of the socio-economic characteristics in the sustainability practices of the farmers. OLS multiple regression analysis of IBM SPSS statistics 21 was used.

1.7 Significant of the Study

There is an increasing proof that sustainable agriculture system has been able or has the ability to improve productivity with slightest damage to the environment in contrast to monoculture, industrial-scale agriculture. Organic agriculture practices are often not new but they have found to attract traditional knowledge and practices, which are presently been assessed by scientific methods. With development and applications that are suitable or appropriate, they present opportunities to improve food production. Even though there are a lot of reports showing the successful record of the transitions to sustainable agriculture and many local- or community-based initiatives or studies at research centres spread out over different areas, we have many farmers still adhere to their old practices.

The most important concern in sustainable agriculture is as regard to how to measure agricultural sustainability. Specific measurement of sustainable agriculture is not possible, however, once definite parameters or criteria are carefully chosen, it is possible to say whether or not certain trends are steady, increasing or decreasing. Farmers can improve the biological stability and resilience of agricultural system by taking agricultural management practices that helps sustain agricultural land potentials and resources based on such observable trends.

Substantial efforts to ascertain suitable indicators and measurements for sustainable agriculture will be made. Most of these indicators that will be used are suitable to evaluate agricultural sustainability at aggregate level, which cannot to be used to ascertain sustainability at the farm level since most farmers made their decision on the choice of technology to use.

In this regards**,** sustaining farmers and society with the preservation of environmental resources are the principal goals of sustainable agriculture**.** The required tools to verify the influence of their management practices on agricultural and natural resource is needed by the farmers this will help them to determine their level of sustainability. These tools, whether they are field assessments or novel ways to use existing information, must be based on easily measured features and offer clearly interpreted evidence if they are to be accepted. The need for approaches to assess agricultural sustainability has never been greater given the widespread economic hardship among farmers and societal concerns over the impact of agriculture on the environment. This necessitates the rationale to carry out this study in developing an agricultural sustainability index for Malaysian agriculture.

1.8 Organisation of the Study

This thesis is organised in five chapters. Chapter 1 describes and discusses in details the concept of sustainability development, agricultural sustainability development, overview of rice industry in Malaysia, rice production in MADA, sustainability issues of rice production in MADA. In this chapter, the research problems, objectives, and significant of the study is further described.

Chapter 2 reviews and discussed selected past studies on the approaches used in determining agricultural sustainability and the methodological issues in this study. Chapter 3 concentrates on the conceptual framework. The methods and techniques used in this study to create the agricultural sustainability index are also described explicitly. The chapter also discussed the data collection and sampling techniques, model specification and the method of data analysis used in this study.

Chapter 4 presents the results of the study, which comprised of the demographic characteristics, farmers' production practices, knowledge, attitudes and perception, sustainability index of rice production as well as the factors affecting sustainability of rice production practices.

Chapter 5 summarizes and highlighted the findings of the study, with conclusion drawn in line with the objectives of the study. Policy implications and recommendations are also discussed in the chapter.

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