STUDY ON EXTERNAL DEMAND CONDITIONS AND INTERNAL SUPPLY FACTORS FOR RICE EXPORT OF MYANMAR

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STUDY ON EXTERNAL DEMAND CONDITIONS AND INTERNAL SUPPLY FACTORS FOR RICE EXPORT OF MYANMAR

A thesis presented by

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The thesis attached hereto, entitled "STUDY ON EXTERNAL DEMAND CONDITIONS AND INTERNAL SUPPLY FACTORS FOR RICE EXPORT OF MYANMAR" was prepared and submitted by Khine Zar Wai under the direction of the chairperson of the candidate supervisory committee and has been approved by all members of that committee and the board of examiners as a partial fulfillment of the requirements for the degree of **MASTER OF AGRICULTURAL SCIENCE (AGRICULTURAL ECONOMICS)**.

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This thesis represents the original work of the author, except where otherwise stated. It has not been submitted previously for a degree at any other University.

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ABSTRACT

Rice as most important agricultural commodity contribute to generate increasing farmers' income as well as to share 14.24% of total export of the agriculture sector for national income during 1990-2010 (CSO, Central Statistical Organization, 2012). The objectives of the study were to determine the factors affecting the export value of major agricultural export commodities, to estimate export demand for Myanmar rice based on economic and demographic indicators of trading partners and to estimate the influencing factors of rice supply for the long term. This study used the time series data from 1990 to 2010.

According to the results, world demand and competitiveness positively and significantly influenced on the export value of major agricultural commodities at 1% significant level. The results point out that world demand and competitiveness play the important role. By improving upon its market share in its traditional exports, Myanmar can increase its exports of major agricultural commodities under given world market conditions. To achieve sustainable agricultural growth, farmers of Myanmar face more difficult than those of other developing countries due to competitiveness of the producers which include the gradual removal of trade barriers, rising demand for higher quality and standard of agricultural commodities. International demand for Myanmar's agricultural commodities is necessary to generate the nation's income in turn to develop the welfare of the farmers. As per importance of competitiveness, it is necessary to boost substantially even though competitiveness of agricultural commodities of Myanmar is weak due to lack of advance technology in agricultural production.

According to the results of external demand conditions analysis, GDP, GDP per capita of Bangladesh and price of competing country (India) significantly influence on the rice export volume of Myanmar at 1%, 5% and 10% respectively. GDP, GDP per capita, production of Indonesia and price of competing country (India) significantly influence on the rice export volume of Myanmar at 1%, 5% and 10% respectively. The results from the gravity model pointed out that export volume of Myanmar rice rely on the economic indicator of trading partners. The import share of Myanmar rice in Bangladesh steadily increased year after year but exception 2006-2007. According to the research findings, the export price of Myanmar's rice was low due to poor quality in comparison with other exporters in the region. Myanmar will have comparative advantage if the export price of rice in competing countries rose. However, it needs to consider the substainable market for Myanmar rice for which the

quality of rice should be improved. In order to get high quality of rice, rice breeding program or selection of good quality traditional rice varieties or introduction of improved or hybrid varieties have to be done. The government needs to emphasize on favourable policies and measures to improve the productivity of rice and to boost the export demand, along with putting initiatives in place to remove non tariff barrier from exports of rice.

According to the results of internal supply factor analysis, lagged sown area, irrigated area and HYV area were statistically significant in the regression of area response function. Sown area and rainfall were statistically significant in the regression of yield response function. Variability of rainfall is also an important constraint to the growth of rice production suggesting the importance of government investment in irrigation systems to reduce the risk of water shortages facing by rice producers frequently. The technological progress of rice production depends on the supply of irrigation facilities and utilization of HYVs but it was stable due to low investment by the government of Myanmar. During the study period, area expansion of rice has been possible only by horizontal expansion rather than vertical expansion.

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LIST OF ABBREVIATIONS

CSO	Central Statistical Organization
DAP	Department of Agricultural Planning
DOA	Department of Agriculture
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agricultural Organization Statistical Database
ha	Hectare
MOAI	Ministry of Agriculture and Irrigation
MOC	Ministry of Commerce
YAU	Yezin Agricultural University
GDP	Gross Domestic Product
GDP per capita	Gross Domestic Product per capita
PPP	Purchasing power parity
P	Production
Pop	Population
Pr	Price
HYV	High Yielding Variety
WD	World Demand
CM	Competitiveness
DV	Export diversification
OLS	Ordinary Least Square
MT	Metric ton
IMF	International monetary fund

CHAPTER 1

INTRODUCTION

1.1 Background of Myanmar Agriculture Sector

Myanmar, one of the ASEAN member countries, is endowed with rich natural resources, such as cultivable land, available water resource and favorable climate for agriculture. Myanmar is an agricultural country. The agriculture sector is essential for providing food for increasing population and for earning foreign exchange.

About 27.5 percent of the gross domestic product (GDP) comes from agricultural sector (Figure 1.1). Agriculture sector is the back bone of its economy. Agriculture sector contributes 28.1% of total export earnings (MOAI 2011-12); and employs 61.2% of the labor force. This indicates that Myanmar economy is still much depending on agriculture sector.

About 70% of the total population resides in rural areas where their main livelihoods depend on agriculture. The major policy objectives of Ministry of Agriculture and Irrigation are to increase production for self sufficiency and to produce an export surplus to boost Myanmar's foreign exchange earnings.

The government's policy measures to promote agricultural production included development of land resources for agricultural expansion, provision of adequate irrigation water for agricultural purposes, support for agricultural mechanization, accelerated transfer of improved new technologies and development and utilization of high yielding quality seeds. Accordingly, production has increased considerably, but the income levels of the farmers in real conditions were not improved.

1.2 Sown Area, Yield and Production of Rice in Myanmar

Myanmar’s major food export items were pulses and rice. Myanmar is rice surplus country for which it can sufficiently provide rice for domestic consumption and export. To provide sufficient rice for domestic consumption in line with food security for increasing population and enhancing income by exporting of rice surplus, the successive Myanmar governments generally have attempted to develop the country’s rice economy.

Rice remains a strategic sector in terms of its significance in the country’s socio-economic development. Rice occupies 33.75% of the total agricultural area in the farm economy and employs around 5 million farmers and family members (MOAI 2012). Rice also contributes 31.33% of total agricultural export of Myanmar (MOAI 2011-12). The production of rice was increased overtime except in some years. Though rice's export value was declined overtime, the production and consumption of rice were increased. The sown area of paddy was increasing from 5.93 million ha in 1994-95 to 8.05 million ha in 2010-11. The production level was also increasing from 17.9 mil tons in 1994-95 to 32.5 million tons in 2010-11. Therefore, the production and sown area of paddy have been increased due to the introduction of summer paddy program in 1992 and increasing irrigation facilities in Myanmar (Figure 1.2).

However, yield of the paddy was increasing at a low rate from 3.17 ton/ha to 4.07 ton/ha during the period of 1994-95 to 2010-11. Myanmar was one of the top ten paddy-producing countries all over the world in 2010 (FAO 2010). Its paddy production level was at 6^{th} position compared with other main paddy producing countries (Table 1.1).

The total sown area of rice in Myanmar has increased from 4.83 million hectares to 7.66 million hectares, the total production also increased from almost 13.2 million MT to about 29.02 million MT between 1991-92 and 2011-2012. Average yield per hectare was also increased from 2.88 MT to 3.83 MT. Total rice sown area, yield and production in 22 years period from 1990-1991 to 2011-2012 are shown in Table 1.2.

Myanmar exported 0.287 million MT of rice in 1991-1992, and it was 2.17 % of total production. Myanmar exported 1.041 million MT of rice in 1994-1995, and it was 5.81% of total production. However, rice export of Myanmar significantly declined from 1995-1996 to 2000-2001. In 2001-2002, rice export had risen again to 939 MT, but the percentage of export was accounted for 4.35% of total production and afterward, it was steadily decreasing.

The world's rice production fluctuated approximately 687 million MT and production of Asia was 613 million MT in 2010-2011. According to the situation of rice production in Myanmar, total rice sown area had reached to 8.05 million hectares (34%) of the total cultivated area, total production was 33 million MT and total export was 0.5 million MT. The comparison of rice production between Myanmar and other main Asian rice producing countries are shown in Table 1.3.Total rice production was 31.25 million MT for Thailand, 38.10 million MT for Vietnam and 32.57 million MT for Myanmar. Export quantity was 9.1 million MT for Thailand, 4.56 million MT for Vietnam and 0.54 million MT for Myanmar. Thailand and Vietnam had nearly the same in rice production but rice export amount of Myanmar is sharply different from those two countries.

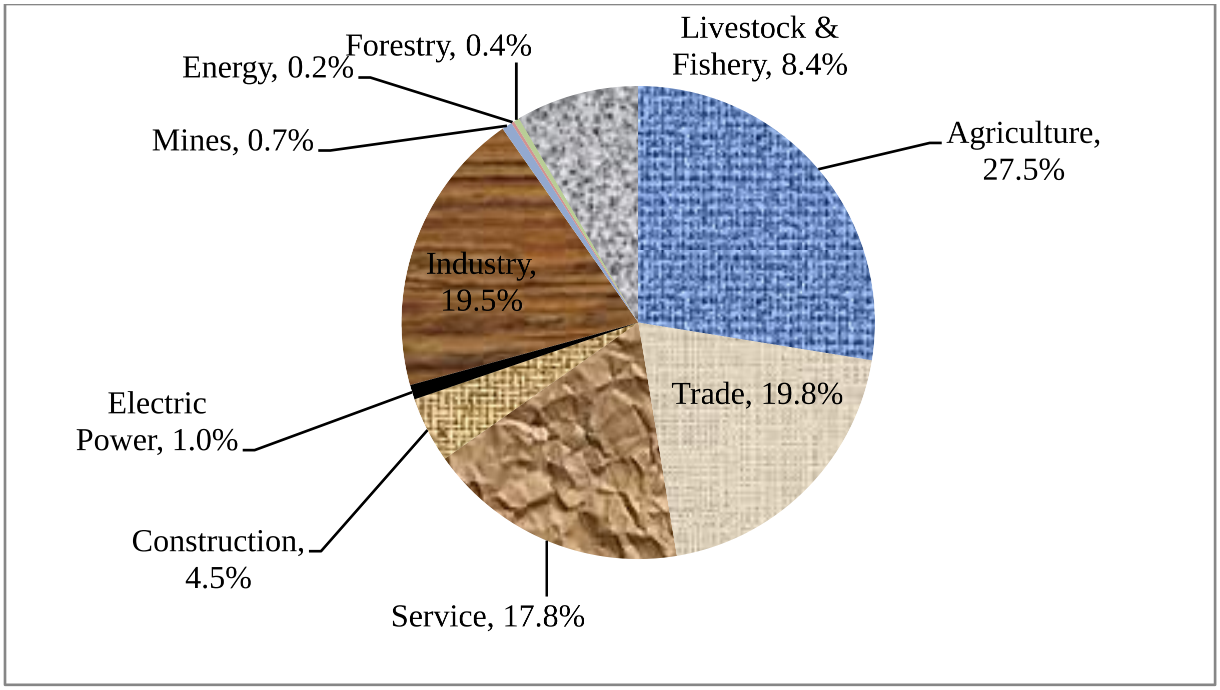

Figure 1.1 Gross domestic product compositions by sector, 2010-2011

Source: DAP, MOAI, 2012.

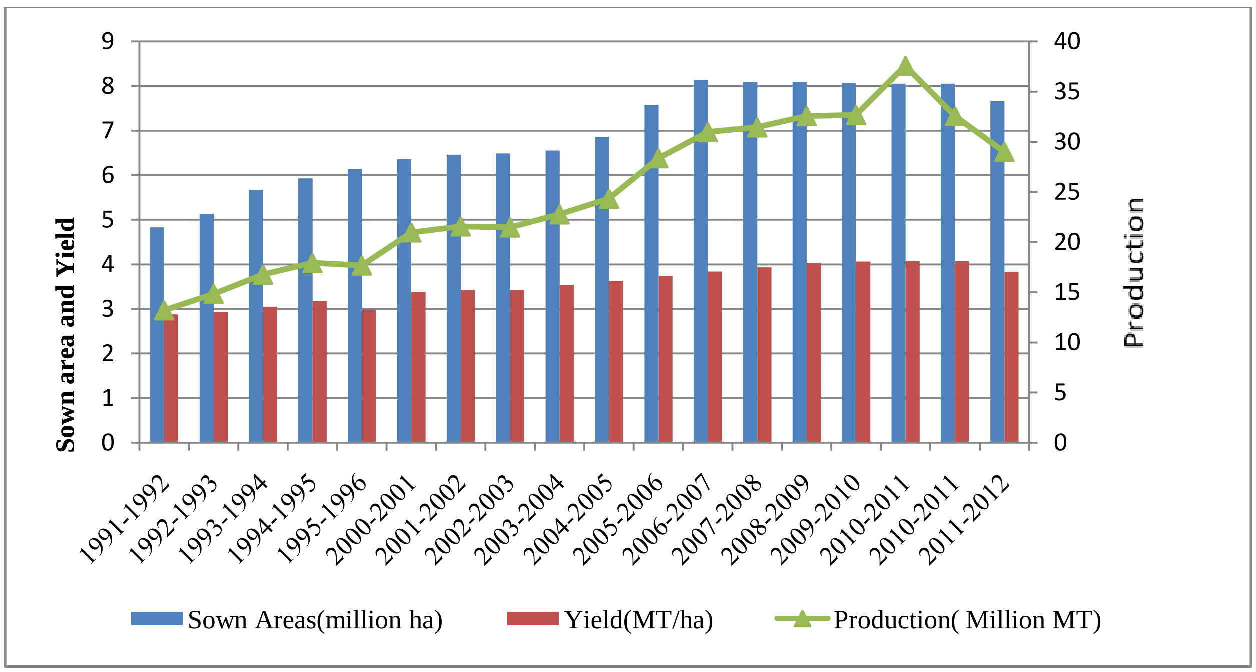

Figure 1.2 Paddy production, sown area and yield in Myanmar

Source: CSO, DAP, MOAI, Various years

Table 1.1 Production of the top ten countries for paddy, 2011

Top ten countries of paddy production	Paddy production (million MT)
China	193.80
India	148.66
Indonesia	59.50
Bangladesh	46.94
Viet Nam	38.10
Myanmar	32.57
Thailand	31.25
Philippines	16.74
Brazil	10. 22
Japan	9.86

Source: MOAI, 2011.

Table 1.2 Sown area, yield, production and export of rice in Myanmar

Year	Sown Area (million ha)	Yield (MT/ha)	Production ('000 MT)	Export ('000 MT)	Export (% of Production)
1990-1991	4.94	2.82	13970	134	0.96
1991-1992	4.83	2.88	13201	287	2.17
1992-1993	5.13	2.93	14837	272	1.83
1993-1994	5.67	3.05	16760	311	1.86
1994-1995	5.93	3.17	18195	1041	5.81
1995-1996	6.14	2.98	17953	354	2.00
1996-1997	5.88	3.06	17676	93	0.53
1997-1998	5.79	3.08	16654	28	0.17
1998-1999	5.76	3.13	17078	119	0.70
1999-2000	6.29	3.24	20126	55	0.27
2000-2001	6.36	3.38	21324	254	1.20
2001-2002	6.46	3.42	21951	939	4.35
2002-2003	6.49	3.42	21805	793	3.70
2003-2004	6.55	3.54	23136	168	0.74
2004-2005	6.86	3.63	24752	182	0.75
2005-2006	7.58	3.74	28370	180	0.63
2006-2007	8.13	3.84	30980	18	0.05
2007-2008	8.09	3.93	31450	359	1.14
2008-2009	8.09	4.03	32573	666	2.04
2009-2010	8.07	4.06	32681	818	2.50
2010-2011	8.05	4.07	32579	536	1.65
2011-2012	7.66	3.83	29010	707	1.93

Source: CSO, DAP, DOA, 2012.

Table1.3 Production and export of rice for Myanmar and neighboring countries (2010-11)

Country	Sown area (million ha)	Yield (MT/ha)	Total Production (million MT)	Export ('000MT)
World	**159.45**	**4.31**	**687.23**	**33081**
Asia	**142.05**	**4.32**	**613.65**	**24943**
Myanmar	8.05	4.07	32.57	536
Thailand	10.52	2.97	31.25	9196
Vietnam	7.28	5.23	38.10	4558
Indonesia	12.14	4.9	59.50	1.2
Malaysia	0.81	3.59	2.91	0.2
Philippine	4.45	3.76	16.74	0.4
Laos	0.81	3.55	2.88	-
Cambodia	2.43	2.75	6.68	2.6
China	29.54	6.56	193.80	1325
Bangladesh	11.74	4.00	46.94	19
India	44.11	3.37	148.66	6450

Source: MOAI, 2011.

1.3 Export System of Rice for Myanmar

Exports from a country not only represent a way to achieve economic growth, but also they provide foreign exchange earnings needed to import the capital and intermediate goods for domestic production and debt servicing obligations (Lord 1991). For instance, economic theory indicateed that higher income elasticity cause exports to be a more powerful engine of growth. Also, higher price elasticities create a more competitive international market for the exports of a particular country; thereby; a real devaluation will be more successful in promoting export revenues (Goldstein and Khan 1985; Lord 1991).

In Myanmar, the importance of conducting research in international trade can be justified by the growing importance of trade in the economy. Myanmar was under the centrally-planned economy since 1962 and was once again subject to the command economy with a partially liberalized trade policy regime since 1988-1989 until the end of the military rule in March, 2011.

Myanmar has been a member of the WTO since 1995 and of the Association of South East Asian Nations (ASEAN) since 1997, and has therefore committed itself to reducing tariffs and dismantling non-tariff barriers over a specified period of time. In April 2003, Myanmar government suddenly announced the second liberalization of rice marketing aimed at ensuring a beneficial paddy price to farmers and at the same time at enabling consumers to get rice at a fair price (MAPT 2003). After the second liberalization, rice exports were still reduced year to year. Myanmar could not fully exploit its potential in the development of rice sector. Myanmar government’s rice export policy was diverged from the neighboring rice export countries’ which attains a remarkable increase in rice production and occupies an extensive share in world rice trade.

Myanmar conducted the import- substitution strategy for about 50 years. The current status is that of a less developed country. Myanmar will have more challenges than opportunities to meet the criteria of AFTA if they are absolutely arranged. Possible options are to participate in the regional production network, to expand and upgrade its production capacity and distribution networks, and to maximize benefits. (San Thein 2006)

For many least developed countries and developing countries, agricultural trade remains an important part of overall economic activity and continues to play a major role in domestic agricultural production employment. The expansion of agricultural exports is considered one of the increasing income and foreign exchange earnings.

Myanmar rice has failed to generate stable export demand and share in percentage of national export and agricultural export value because of its export regime which depended greatly on the government's marketing policies. The export earning of rice decreased from year to year. Myanmar’s agricultural export largely consists of a few low value-added primary commodities. Myanmar’s export commodities are highly vulnerable to instability in supply, demand and a decline in terms of trade and still facing many internal supply side constraints associated with its underdeveloped economy which renders its export uncompetitive. Not only was rice an important share of the economy, but it was also a key source of foreign exchange earnings and government revenue.

Before Second World War, Myanmar stood as a top rice exporting country in the world. In the early 1940s, the country produced about 8 million tons of paddies and stood first among the rice exporting countries in the world. However, because of stagnation of production since the early 1960s, Thailand took the place of Myanmar in the export market, as exports declined from 1.7 million MT in 1962 to 0.3 million MT in 1975.

Myanmar exported about 168.4 thousand MT of rice in 2003-2004, and it was 0.74% of total production. However, subsequent year up to 2006-2007, rice export of Myanmar significantly declined. Then, in 2007-2008, rice export had raised again to 358.5 thousand MT, but the percentage of export on total production was accounted for 1.16% and after that, it was gradually increasing in Figure 1.3.

To provide income for poor rural households, agricultural exports are expected either through production or employment. Large numbers of people have indeed benefited: peasant farmers, farm laborers, fishermen, intermediate traders and purchasing agents who deliver to processors and exporters. Myanmar’ rice exported South East Asia, rest of Asia and other countries, etc. Other countries include Middle East, America, Europe and Africa. During 2009-10, Myanmar's rice was mainly exported to South East Asia (14.26%), Africa (67.5%), Rest of Asia (1.47%) and others (1.05%) in Figure 1.4. Share of rice export value increased to 16.9% in 2009.

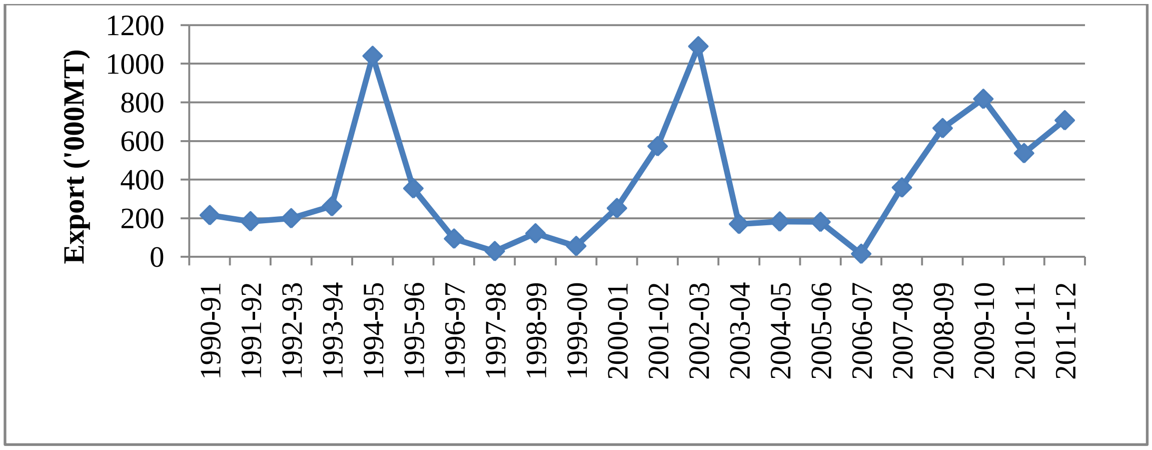

Figure 1.3 Trends of rice export (1990-2012)

Source: CSO, Various years

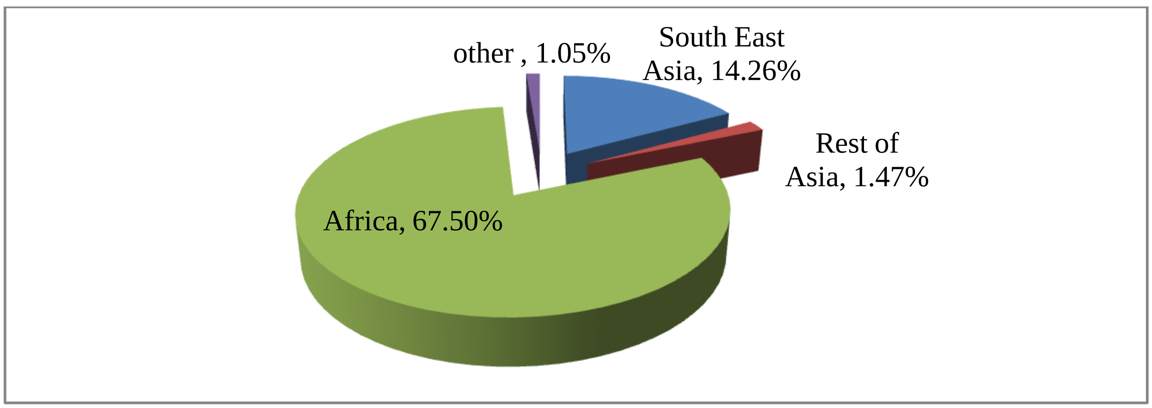

Figure 1.4 Total export of Myanmar's rice from 1990-91 to 2009-10

Source: CSO, Various years

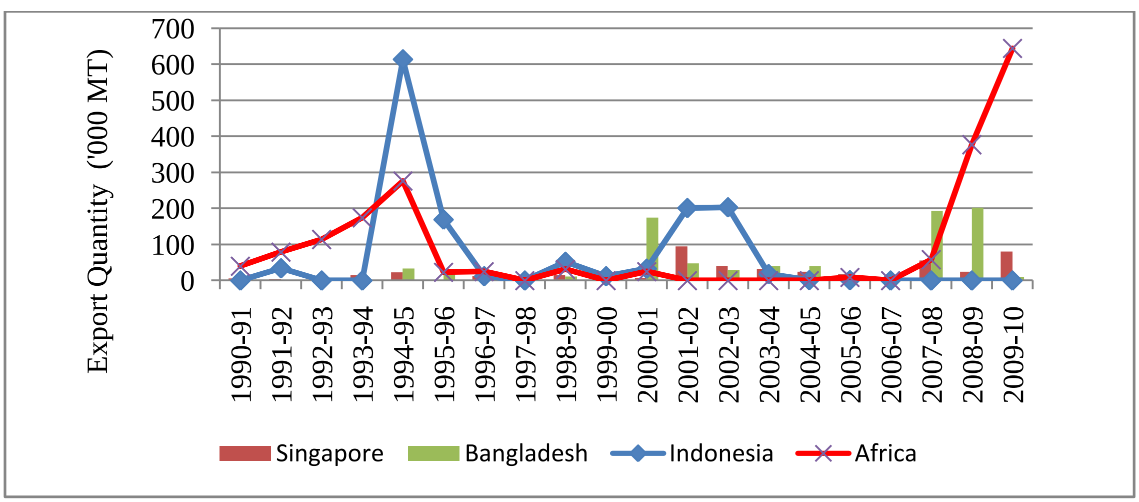

Figure 1.5 Export trend of Myanmar's rice from 1991 to 2010

Source: CSO, Various years

Export of rice for Myanmar significantly declined between 1995-1996 and 2000-2001. In 2001-2002, rice export had risen again but afterward, it was steadily decreasing. The share of agricultural export of rice from Myanmar to the world market had fluctuated. Myanmar's rice exported all over the world. Among these, it exported mostly Indonesia, Singapore, Bangladesh and Africa (Figure 1.5). In 1994-95, rice exported the highest to Indonesia and afterward significantly declined. The exported rice to Africa was gradually increased in 2008-2009 and 2009-2010.

Myanmar exported more than 790,000 MT in 2011, eighth among the top ten rice exporting countries. Those countries were Thailand, Vietnam, India, Pakistan, Brazil, Cambodia, Uruguay, Myanmar, Argentina and China. If Myanmar exports 1.5 million MT of rice during this fiscal year, it will overtake Uruguay, Cambodia and Brazil and reach fifth place. Myanmar's rice exports average more than 100,000 MT a month. It exported almost 700,000 MT, worth US$ 260.315 million, from April 1 to October 19, according to Ministry of Commerce (MOC). The Myanmar Rice Federation (MRF) plans to export rice from its reserves. Exports are expected to reach 1.5 million MT (Official of MOC). Myanmar expects rice-export volumes to reach 3 million MT by 2017. To achieve this, it requires increasing the per-hectare yield. A ton of Myanmar rice costs US$ 365 in the world rice market. Thai rice is priced at US$ 566, Vietnamese US$ 425, Indian US$ 410 and Pakistan US$ 380. Myanmar's rice is priced lower than the other countries, but the price for export to China is US$ 430. This is more expensive than Vietnamese rice as Myanmar is reluctant to export rice to China because of its strict rules on quality and import tax.

In 2011-12, Myanmar exported over 800,500 MT of rice, of which 75 percent were sold to Africa, Bangladesh, Indonesia and the Philippines. In January, a memorandum of understanding was signed between Myanmar and Indonesia on exporting 200,000 MT of Myanmar rice in a year. Myanmar has the potential to become the Asia's "next economic frontier" if it takes advantage of its natural resources.Targeted markets for white-rice sales are Africa, Indonesia and the Philippines. Myanmar has agreed to sell 200,000 MT of white rice to Bulog, Indonesia's state food agency.

1.4 Problem Statements

In many developing countries, rice self-sufficiency objectives continue to be pursued as a means to achieve food security. To protect producers and consumers from large price fluctuations, governments intervene to stabilize their market. Myanmar economy has been dominated by agriculture sector around 40-50 percent of GDP and its 70 percent of population have been living in rural areas. Ninety percent of people in rural area work in agriculture sector and over 50% grow paddy (MOAI 2012).

Being a developing country, Myanmar still needs every sector to be developed. Decades ago, Myanmar was the largest rice exporter in the world. The agricultural sector especially rice export is still indispensable to be promoted in Myanmar. The success of Myanmar rice export is influenced by the economic conditions of its international trading partners.

The difficulties facing in exporting rice are low quality rice, market instability, external demand constraints and internal direct and indirect restrictions. To penetrate the world rice market by high quality rice export, uniform quality rice will be necessary from good rice varieties. A stable and sufficient supply of rice in Myanmar is seen as directly related to people’s livelihood and to the security of the nation. If price of rice is increased and market is stable, the income of rural people will be increased. If the income of rural people increased, national economy will increase. Thus economic development of the country is dependent on improvement in the agriculture sector. To increase the national economy, Myanmar needs to increase the export potential for exporting commodities.

The external trade is limited only to limited amounts of available surplus. Local businessmen cannot supply the quantity required or conform to the quality standards specified. Moreover, the available surplus cannot be procured, graded, or shipped in time. Quality control is lacking or non-existent. Transport and storage facilities are inadequate. The lack of infrastructure and support is another stumbling block responsible for the slow growth of the export sector.

In long term, stable price and stable market of rice definitely important to give incentive to farmers. Moreover, price stability of rice is the important factor for the farmers and traders. So, it is needed to know market information as a foundation in both decisions making process of crop production plan and trading. Getting timely the market information is an important fact for farmers not only in deciding time and space to sell but also in storing and planning of crop production.

Myanmar tries to find out on other potential markets for rice, which have incentive price and stable market for the farmers and traders. In addition, production of rice depends on the market demand from most Asian countries. Therefore, it is necessary to estimate supply and demand in domestic and export rice markets.

1.5 Objectives of the Study

The objectives of the study are as follows:

1) To determine the factors affecting the export value of major agricultural export commodities
2) To estimate export demand for Myanmar rice based on economic and demographic indicators of trading partners.
3) To estimate the influencing factors of rice supply for the long term in Myanmar.

1.6 Outline of the Thesis

The first chapter of this work will focus on the development of the problem statement, a justification concerning the identified problem, as well as the establishment of detailed research procedures that will provide the framework for the development of this thesis. The remaining chapters are outlined as follows; the second chapter will provide a review of literature on external demand and internal supply analysis with emphasis on time series studies. A summary of export promotion efforts by the government of Myanmar, along with a description of export demand and internal supply strategy will be included. Chapter three will introduce the methodology with an emphasis on recent econometric developments in time series analysis. Chapter four mentions the factors affecting the export value of major agricultural export products. Chapter five shows the export demand for Myanmar rice based on economic and demographic indicators of trading partners. Chapter six explains the influencing factors of rice supply for the long term in Myanmar. The final chapter will provide conclusions and recommendation of the research.

CHAPTER 2
LITERATURE REVIEW

2.1 Theoretical Background of Export Performance

Economic development is the most important policy objective in Myanmar and export is seen as an engine for growth. Johnston and Mellor (1961) reported that expansion of agricultural exports is considered one of the most promising means of increasing income and augmenting foreign exchange earnings, particularly for a country stepping up its development efforts. Export is generally considered to play an important role in the economic growth of a country. Once a country establishes a certain share of the world market for a particular product, export performance is then highly dependent on external demand factors.

Schultz (1964) says that agriculture is treated as a source of economic growth, which can act as an engine of development, but the form of investment is important for the realization of this goal. Incentives to guide and reward farmers are seen as an important component of the investment to increase agricultural production. Transforming traditional agriculture into a highly productive sector depends on the investment made on agriculture and the form it takes, makes it profitable. Schultz continues to say that once traditional agriculture is established, the equilibrium is not readily changeable. He further hypothesizes that there are comparatively few inefficiencies in the allocation of factors of production in traditional agriculture.

Clayton (1964) noted that it is important to know the problem facing peasant agriculture if they are related to raising agricultural productivity. Schultz (1965) says that the technological possibilities have become increasingly more favorable but the economic opportunities that are required for farmers in the low-income countries to realize their potential are far from favorable. He suggested that government intervention is the primary cause of lack of optimum incentives. It therefore becomes important to determine the conditions that are both necessary and sufficient to attain the optimum increase in agricultural productivity.

2.1.1 The concept of competitiveness and diversification

Competitiveness is an indicator of the ability to supply goods and services at the location and in the form and at the time sought after by buyers, at prices that are as good as or better than those of potential suppliers, while earning at least the opportunity cost of returns on resources employed (Frohberg and Hartman 1997). Thus, a competitive firm or industry or country have the ability to satisfy the consumer with a product of the right price, right quality, right packaging etc. i.e. creating place, time and form utility. Such an institution therefore beats the competitors for the scare Dollars and Pounds etc. of the consumer (Esterhuizen *et .al* 2001).

Export diversification is variously defined as the change in the composition of a country's existing export product mix or export destination (Ali, Alwang and Siegel 1991), or as the spread of production over many sectors (Berthelemy and Chauvin 2000).

From a narrow point of view, agricultural diversification implies increasing the variety of agricultural commodities produced at the farm level. From this point of view, Southeast Asia was remarkably successful in agricultural diversification in the nineteenth and early twentieth centuries (Hayami 1991) when in response to growing demand from the West for tropical products, new lands were cultivated with cash crops such as sugar, coffee, tea, and rubber. Agricultural diversification in this narrow sense may also be the response of subsistence farmers to reduce risks arising from climatic, biotic, or seasonal factors.

A broader point of view suggests that agricultural diversification is a process accompanying economic growth, characterized by a gradual movement out of subsistence food crops (mostly rice in Southeast Asia) to a diversified market-oriented production system, triggered by improved rural infrastructure, rapid technological change in agricultural production, particularly food staple production, and diversification in food demand patterns (Rosegranta and Hazell 1999). Effective diversification will require key investments in infrastructure and institutional changes to promote the private sector, particularly in rural areas.

Diversification can occur at the micro, regional, and macro level. At the micro level, the individual household diversifies in order to strengthen and broaden its sources of farm and non-farm income. That may involve both horizontal diversification toward new agricultural commodities and vertical diversification into non-farm activities such as marketing, storage, and processing.

2.1.2 Theoretical background of the gravity model

Gravity Model was first applied to the study of international trade flows by Tinbergen (1962) and Poyhonen (1963). Their separately found that trade flows from one country to another depend on primarily on two forces: one is called attractive force, usually expressed by the country's scale economy measured by GDP, while the other is called exclusive force, usually expressed by the geographical distance between the two countries. The basic expression of Trade Gravity Model is:

$$T_{ij} = A\frac{G_i G_j}{D_{ij}}$$

T_{ij} is the trade flow from one country (assumed i) to another (assumed j). G_i and G_j are their GDPs. D_{ij} is the geographical distance between them and A is the proportion constant.

Although Tinbergen and Poyhonen didn’t base on many theories in the research on Trade Gravity Model but on the experience estimation of the real trade relations, the basic theory of Trade Gravity Model has been gradually enriched in the subsequent studies. In particular, Trade Gravity Model is unique in the interpretation of bilateral trade issues, and can explain many phenomena that the traditional trade theories can’t answer to. Therefore, since the putting up in the early 1960s Trade Gravity Model has immediately concerned by many scholars and many expand researches. Different scholar brought a number of new variables based on the original model according to their own research purposes, such as population, per capita income, exchange rate, economic organizations, language, culture, the common border, and so on, greatly enhanced the intensity in practice of the model’s explanation. In application, Trade Gravity Model has been not only successfully applied to the trade-related fields, but also widely used in exchange rate, immigration, tourism and other economic and social fields, and even introduced by some scholars to explain the impacts on bilateral trade by the trade restrictions,

Exports are influenced through many channels. These channels can be classified broadly into two groups. One channel refers to demand-side factors, which can lead to a sudden turnaround in growth, while the other channel refers to supply-side factors. If supply-side factors are not favorable, this may prevent a quick revival of exports and may also act as an obstacle to maintaining high growth for a long period.

2.1.3 Conceptual model of rice production

Rice production in any country is the result of producers' planting decisions in each year and can be represented mathematically as:

$$S_t = H_t * Y_t$$

where S is the quantity of rice produced, H is the rice area harvested, Y is the yield of rice per unit of area (acre or hectare), and t represents the current time period. The area harvested is a function of the area planted by producers as affected primarily by weather and possibly some economic variables. Likewise, yield is a function of weather but also of technical change. Thus, the principal behavioral variable is the area planted to rice. In other words, the variable that is most directly affected by rice producer decisions is not production per se but rather the area planted to rice. Production each year, then, is what results from those decisions as affected primarily by weather and technological change.

Theoretically, in any period t, the desired area to be planted each year (A^d) is a function of expected price (P^e), weather (W), and other explanatory factors (Z):

$$A_t^d \; f(P_t^e, W_t, Z_t)$$

In this study, weather is defined as the amount of rainfall and Z_t includes the availability of agricultural labor. The availability of agricultural labor is included as an explanatory variable in this equation because labor shortages have reportedly had a negative impact on rice production, as suggested in the previous section.

The relationships between these variables can be represented as the following linear equation:

$$A_t^d = \alpha_0 + \alpha_1 P_t^e + \alpha_2 R_t + \alpha_3 L_t$$

where R_t is anticipated level of rainfall, L_t is the projected availability of labor, and α_0, α_1, α_2, and α_3 are the parameters to be estimated.

Farmers are generally unable to respond to sudden changes in economic conditions. Therefore, actual changes in planted area from year to year are usually less than desired due to time and resource constraints. Assuming partial adjustment, the actual change in area planted in time t is specified a fraction (δ) of the difference between desired area planted in time t and the actual area planted at time t-1 (Labys 1973):

$$A_t = \beta_0 + \beta_1 P_{t-1} + \beta_2 R_t + \beta_3 L_t + \beta_4 A_{t-1}$$

The lagged area planted is intended to capture the effects of fixed production factors such as equipment, technical expertise, and other inputs. Such factors imply that the area planted in year t is determined to some extent by how much area was planted in year t-1 (Petcharatana). All of the independent variables are expected to have a positive effect on rice area planted.

2. Role of Export Performance

Export performance is not only depends on international demand but also on its competitiveness and diversification. The challenging issue of Myanmar's agricultural export has been greater dependence on a smaller number of exportable commodities for foreign exchange earnings. In theory, export diversification can be attained by changing the shares of commodities in the existing export pattern or by including new commodities lines in the export portfolio.

The performance of the agricultural export of Myanmar is the result of the movement of markets that the country participates in and the supply response of the country. Therefore, the export growth could be explained by investigating the changes in demand and supply factors in the markets. The expansion of the international market for traditional export commodity is considered a major factor on the demand side. The major factor on the supply side that influences export performance is the country's ability to maintain its competitiveness in exports of traditional products and to diversify into new products lines (Athukorala 1991).

2.3 Reviews of Methodology Analysis

Nadeem Malik (2007) has analyzed the impacts of economic reforms and trade liberalization policies on agricultural export performance of Pakistan. The major purpose was to examine the effects of both domestic supply-side factors and world demand on agricultural export performance. Four indicators of economic reforms and trade liberalization policies were considered namely competitiveness, diversification, openness and world demand for agricultural products; these indicators capture the effects of both domestic supply-side policy reforms and world market potential. The effects were analyzed in dynamic term both in the long-run and short-run, using co integration and vector error correction (VECM) methods. The empirical results suggested that agricultural export performance was more sensitive to the domestic supply-side conditions. These findings supported the importance of domestic policies designed to improve domestic supply conditions aimed at promoting agricultural exports. The empirical conclusions also indicated that there exists a unique long-run or equilibrium relationship among real value of agricultural exports, competitiveness, diversification, openness and world demand for agricultural products.

Nay Myo Aung (2009) has been examined the relative importance of external demand conditions and internal supply factors for agricultural export performance. The results showed external demand certainly plays an important role in the one hand, Myanmar can expand its exports under given world market conditions by improving upon its market share in its traditional exports and diversifying into new product lines providing it pursue appropriate domestic economic policies. The country needs flexible adjustments to changing world market conditions to be able to switch from one line of agricultural exports to another. But the situation facing the farmers of Myanmar today may be more difficult than that of other developing countries that achieved sustained agricultural growth in the last three decades. Myanmar’s economy now has to compete in a more fiercely competitive world market. The gradual removal of trade barriers, rising demand for higher quality products and higher standard, the continuous erosion of trade preferences and the costly compliance with the new trade rules are particularly problems that may hamper the competitiveness of the producers. To raise agricultural productivity and to generate agricultural income, farmers need to keep pace with increasing domestic demand for food and to meet requirements for enhancing competitiveness and diversification.

Otsuki, Wilson and Sewadeh (2001) used Trade Gravity Model to study the agricultural trade between European countries and African countries. And the results show that: the enhancement of technical inspection standards in agriculture (Aflatoxin Residue) by European countries would lead directly to the reduction of African agricultural exports volume.

Bergstrand (1985) addresses critics of the gravity model's perceived lack of a strong theoretical foundation in asserting that the gravity model was in fact a reduced form derived from a four equation partial equilibrium model of export supply and import demand. He provides an "explicit theoretical foundation for exporter and importer incomes and per capita incomes consistent with traditional (and newer) trade theories". Bergstrand reiterates that his goal was to shed further light on developing a Gravity Equation that was consistent with the theories of inter and intra-industry trade. He further states using a two-industry, two-factor, N-country Heckscher-Ohlin-Chamberlin-Linder model, one could interpret exporter and per-capita income as national output in terms of units of capital and the country's capital-labor endowment ratio. Bergstrand also proposed that between 40%-80% of the variation across countries was explained by the generalized gravity equation in one-digit SITC trade flows. He stated that importer per capita income coefficients suggested that manufactures tended to be luxuries and that raw materials tended to be necessities for everyday life (such as fuels and chemicals). The perceived disparities between the gravity equation and the Heckscher-Ohlin (H-O) Model of trade have also been addressed by Deardorff.

Idsardi, E. (2010) studied that the determinants of agricultural export growth in South Africa. The objective of his paper was to estimate the determinants of South Africa's upcoming agricultural exports by applying the gravity model. The aim of this exercise is to gain knowledge on agricultural trade diversification and export growth to ultimately provide guidelines for future export opportunities.The results from the gravity model are not one-sided, as a variety of the investigated factors were found significant, although differing per product. One of the main findings was that the specified models do explain the variation in the export flows of the "champions" to a large extend. Thus exogenous factors will have a limited effect on the export of these products. The three factors that were found to be most significant in all the gravity models are population (physical market size), GDP of the trading partner (economic market size) and GDP of South Africa (supply capacity). Of less importance are: having a common border (natural links between trading partners), GNI per capita (stage of economic development) of the trading partner and South Africa and exchange rate (financial risk & currency devaluation). The total size of the specific export market for the relevant product group is also of lesser importance to the flows of emerging agricultural exports.

Gravity model has been extremely successful empirically. Models of this type have now been estimated for a wide range of countries. Radman (2003) use import export and total trade, three equations to investigate trade flow between Bangladesh and its major trading partners. He found that Bangladesh's trade in general is determined by the size of the economy, GNP per capait, distance and openess. Blomqvist (2004) applies gravity model to explain the trade flow of Singapore and as usual with gravity model, a very high degree of explanation is achieved especially for the GDP and distance variable. Anaman and Al-Kharusa (2003) on the other hand show that in a gravity model framework, the determinant of Brunei's trade with EU is mainly from the population of Brunei and EU countries.

Yuli Haryati and Joni M. M. Aji (2005) studied about Indonesia rice supply performance in the trade liberalization. The result of this study showed that introduction of reasonable tariff and government involvements were still required to stabilize the rice supply system in Indonesia. Removal of import tariff and government involvement, e.g. BULOG, would significantly reduce producer surplus. This would subsequently reduce the competitiveness of rice production and create more constraints for rice producers in Indonesia. With regard to government policy, food security should not only be translated as the availability of inexpensive food for consumers but also the willingness of producers to produce more rice in the future. While tariff should be gradually reduced by the agreements, Indonesian government should provide better technology and institutional instrument supports for rice producers that mostly are small farmers.

Rudy Rahmaddi, Masaru Ichihashi (2011) investigated the aggregate export demand and supply behavior in Indonesia for the period of 1971- 2007. This result suggested that relative price and world income was significant factors playing roles in determining demand for Indonesia's exports. The magnitude of relative price and income elasticities both were higher than one implying that world demand for exports were highly responsive to price and income. Exports price also significantly contributed to the long-run supply for Indonesia exports, whose magnitude of elasticity were higher than that of demand. This supports previous conjectured arguing that supply side rather than demand side was the more relevant determinants for Indonesia export performance. The result indicated that productive capacity and capacity utilization rate had significant impact on supply of Indonesia's exports. Statistically, the estimated coefficients were stable over the period under study and all findings draw some significant policy implications including macro and microeconomic policies, all of which were essential to maintain and improve the demand and supply of Indonesia's exports. Nevertheless, since this study was performed based on aggregated data, it might be useful for future research to extend the analysis to see the behavior and determinants of exports by employing more disaggregated data.

Mbithi (2000) says that the supply response has an impact on economics as well as on agricultural development, poverty, equity and the environment at large; so, policy makers need supply response information on both individual activities and on the sector aggregates.

Additional results indicate that export demand from developing countries show, in general, lower price elasticities than developed countries, except by Asian developing countries which have showed significantly higher price elasticities than both industrial (Senhadji and Montenegro,1999) and other developing countries (Senhadji and Montenegro,1999; Reinhart,1995). In contrast, other researchers (Faini, et al., 1992) have concluded that because of export competition among several developing countries, there is no sufficient empirical evidence to assess whether an export-led development strategy can be successfully adopted.

Goldstein and Khan (1985) recent results support the point that trade movements are significantly more responsive to relative prices in the long run than in the short-run (Kinal and Lahiri, 1993; Senhadji, 1998; Senhadji and Montenegro, 1999). Additionally, these researchers found also a similar pattern response of trade flows to income changes. Changes in income play an important role in the determination of export and import demands of developed and developing countries (Bond, 1987; Kinal and Lahiri, 1993; Marquez and McNeilly, 1988; Reinhart, 1995; Rittenberg, 1986; Senhadji and Montenegro, 1999). Also, according to Reinhart (1995); Senhadji (1998); and Senhadji and Montenegro (1999), industrial countries' income elasticities are higher than their counterparts developing countries.

Jose R. Andino (2004) studied that export demand for Costa Rica, El Salvador, Guatemala, Honduras and Panama were estimated to determine the effects of changes in income and relative export price when trade occurs among Central American countries (CAC). Results indicate that trade among CAC can be a powerful engine of growth, as indicated by significant positive responses of value of exports to a positive shock in income levels. However, relative export price plays an important role in promoting export revenues for El Salvador and Honduras only. The export response to a shock in income for El Salvador and Honduras lasted fewer periods and was lower compared to those from Costa Rica, Guatemala and Panama.

Afzal (2005) estimated the demand and supply of exports in Pakistan for aggregate. Aggregate and primary export demand have less than unity price elasticity while for manufactured exports price elasticity is greater than unity. The income elasticity was found less than unity for aggregate and manufactured exports and it has not correct sign in case of primary exports.

Zarenejad (2012) analyzed the factors that affect the supply and demand for Rice Export in Iran. The empirical results showed that the parameter of the export demand and supply model are statistically significant at high significant levels and have good explanatory power. The goal of this paper was to test the existence of long run relationship determinants of supply and demand for Rice Export in Iran. This objective was aided by the technique of Pesaran et al.6 approach to co-integration. The results at relationship between supply and demand for rice export and its determinants confirm the studies of Goldstein and Khan (1985) but our results are more vigorous. The policies should be concentrated to increase yields and to achieve higher quality standards which are essential to sustain a suitable profitability level of production on one side and to maintain the country's share in the international markets on the other side. Also to maintain Iran's export share in global market and achieve new markets, Government should regulate for investment in packing and also other requirements of supply and demand for Rice Export Orchards. If the government lets the exchange rate to float, it will cause a decrease in export prices and an increase in the volume of Iran's export; following all of these, the prices will become real.

Haughton et.al (2004) estimated the rice supply for Vietnam in their study of "the effects of rice policy on food self-sufficiency and on income distribution in Vietnam" using Cobb-Douglas production function including sown area, the number of labour used in cultivation and other variables such as the intensity of agricultural extension activities, or the educational level of farmers. They found that the most important determinant of rice output is the area of land cultivated. Their estimation results indicated that if the wage rate rises by the equivalent of 1 kg of paddy rice per day, or about 10 percent, then the quantity of rice will fall by 14 kg per household (about 7 percent).

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Data Collection and Source

This study was based on the secondary source of data to estimate export demand for Myanmar rice and to estimate the influencing factors of rice supply for the long term. All data sets were collected from different sources for 21 years period from 1990 to 2010. The relevant secondary information were taken from published and official records of Ministry of Agriculture and Irrigation (MOAI), the Department of Agricultural Planning (DAP), Department of Agriculture (DOA), Food and Agricultural Organization (FAO), FAOSTAT, World Bank Database, World Integrated Trade Solution, Central Statistical Organization (CSO) and other related institutions. The collected secondary data for each analysis are presented in Table 3.1, 3.2, 3.3, 3.4, 3.5 and 3.6 respectively.

3.2 Method of Analysis

3.2.1 Descriptive analysis

Descriptive analysis was done for export conditions, total and average production of farmers by using Microsoft excel software program. Both qualitative and quantitative data were firstly compiled in the Microsoft Excel program. The study was employed with regression analysis for major agricultural export products, export demand analysis for Myanmar rice, and internal supply analysis for rice. The regression models were analyzed by Eviews 5.

For time series data, descriptive evaluation of agricultural export products (rice, pulses, maize, and rubber) were done to understand the importance of world demand, competitiveness and diversification of main agricultural export products. GDP, GDP per capita of importing countries, purchasing power parity in importing nations, production in importing nations, population in importing nations, price competing exporting countries (India and Vietnam) and world market price were included in export demand characteristics. Moreover, yield, sown area, lagged paddy price, irrigated area, HYV area, urea prices, annual rainfall were also included in supply behavior of rice for export. The variability was measured by coefficient of variation (CV %) and standard deviation (SD) measures.

Table 3.1 Description of variables used for major agricultural export commodities

Variable (Secondary Data)	Data description	Source
Export value of rice	1990-2010, million US$	CSO Database
Export value of pulses	1990-2010, million US$	FAO STAT database
Export value of maize	1990-2010, million US$	MOAI, DAP, DOA
Export value of rubber	1990-2010, million US$	World Bank database

Table 3.2 Countries included in the dataset for export demand of rice for Myanmar

Name	Country
Importer	Bangladesh, Indonesia
Exporter	Myanmar
Competing country with Myanmar	India, Vietnam

Table 3.3 Description of variables used for export demand of rice

Variable (Secondary Data)	Data description	Source
GDP in importing countries	1990-2010	World Bank database
GDP per capita of importing countries	1990-2010	World Bank database
Purchasing power parity of importing countries	1990-2010	World Bank database
Production of importing countries	1990-2010,million MT	World Bank database
Population	1990-2010,million person	World Bank database
Price competing countries	1990-2010, US$/MT	FAOSTAT, Rice Market Monitor
World market price	1990-2010, US$/MT	FAOSTAT, Rice Market Monitor

Table 3.4 Independent variables and expected sign

Independent variable	**Description**	**Expected sign**	**Theoretical explanations**
GDP	Gross Domestic Product of importer countries	+	Reflecting the size and growth potential of rice market demand (supply) of a country (region), the greater the GDP is, the stronger the capacity of rice demand or supply will be.
GDP per capita	Per capita Gross Domestic Product of importing country	uncertain	Explained above
PPP	Purchasing power parity of importing country	+	The greater the PPP is, the stronger the rice demand or supply capacity will be.
Production	Production of importing country	-	The greater the production, the lower the rice demand will be.
POP	total population of importing country	uncertain	- Larger population means more diversification and self-sufficient (negative sign) - Larger population allows economies of scale resulting in more exports (positive sign)
Pr_{india}	Price of competing country, India	-	If the competing country’s price increases, export demand will decrease.
$Pr_{vietnam}$	Price of competing country, Vietnam	-	If the competing country’s price increase, export demand will decrease.
$Pr_{worldprice}$	World rice price	-	If world’s rice price increases, export demand will decrease.

Table 3.5 Desription of variables used for export demand models

Model	Variable (Secondary Data)
1	GDP, GDP per capita, PPP, Production, Population of importing countries, Price of India, Price of Vietnam and World rice price
2	GDP, GDP per capita, PPP, Production, Population of importing countries, Price of India, Price of Vietnam
3	GDP, GDP per capita, PPP, Production, Population of importing countries, Price of India and World rice price

Table 3.6 Description of variables used for supply function

Variable (Secondary Data)	Data description	Source
Sown area	1990-2010, ('000 ha)	Ministry of Agriculture and Irrigation
Production	1990-2010, ('000 MT)	Market information Service (MIS)
Yield	1990-2010, (ton/ha)	Department of Agricultural Planning(DAP)
Irrigated area	1990-2010, ('000 ha)	Department of Agriculture (DOA)
HYV area	1990-2010, ('000 ha)	CSO Database
Lagged price of paddy	1990-2010, kyat/MT	
Price of urea	1990-2010, kyat/bag(50 kg)	
Annual rainfall	1990-2010, millimeter	

3.2.2 Unit root test

Although traditional regression models assume that both the dependent and independent variables are stationary and that the errors have mean zero and constant variance, a common concern in standard regression models is the presence of unit roots in the series since most economic time series normally behave with stochastic trends. With evidence of unit roots, the series are said to be intergraded of order one I(1), meaning that they must be modeled in first differences ($\Delta y_t = y_t - y_{t-1}$) to make them stationary. A time series is stationary if it does not change overtime, which implies that its values have constant variability. Thus, unit root tests account for possible correlation of unit roots in the first differences in the time series. Augmented Dickey-Fuller (ADF) will also be applied in this study.

3.2.3 Cointegration test

Cointegration is a statistical tool for describing the co-movement of economic data measured over time, that is, cointegration attempts to measure common trends in series over the long run. Two (or more) non-stationary time series are said to be cointegrated if a linear combination of the terms results in a stationary time series.

Some key points to remember are that cointegration refers to a linear combination of non-stationary variables; also, when testing for cointegration, all variables must be integrated of the same order; and, if a series has “n” components there may be as many as “n–1” linearly independent cointegrating vectors.

To test whether the variables of a system of non-stationary processes are cointegrated becomes critical in multivariate non-stationary time series studies. Johansen and Juselius (1990) provide a maximum likelihood estimation procedure for determining the number of significant (linear) cointegration vectors, under the assumption that Y(t) is a vector of processes that are multivariate Gaussian as well as I(1). The Johansen procedure will be used to test for cointegration in this study.

3.2.4. Econometric analysis

3.2.4.1 Econometric analysis for major agricultural export commodities

Export value of rice, maize, pulses and rubber are used in the following model due to Kravis (1970), to explain the change in real agricultural exports (XV_t):

$$XV_t = f(WD_t, CM_t, DV_t) \qquad (1)$$

where XV is the volume of total agricultural exports. WD is world demand for exports of traditional agricultural products for Myanmar. CM is competitiveness in traditional agricultural products. DV is the agricultural export diversification and t mentions time.

First, world demand or export market potential for a set of traditional export commodities WD_t is measured in terms of a weighted-average index of constant price world exports of related commodities at time:

$$WD_t = \sum_{i=1}^{n} \alpha_{it} Wx_{it}$$

where α_{it} is the share of the commodity i in the country's total agricultural exports, Wx_{it} is constant price index of world exports for commodity i, and n is the number of commodities exported.

Second, competitiveness in traditional exports, or an index of competitiveness in traditional agricultural exports, is the ratio of total real agricultural exports to total 'hypothetical' agricultural exports. Hypothetical agricultural exports are estimated by assuming that the country has maintained its initial market share in the agricultural exports of these commodities. It can be given by:

$$CM_t = 100 \left[\frac{\sum_{i=1}^{n} Xp_{it}}{\sum \beta_i Xw_{it}} \right]$$

For each ith main commodity, Xp_{it} is the agricultural export earnings of the given country; Xw_{it} indicates value of world agricultural export, where β_i is the initial-period world market share (1990-2010), where i=rice, pulses, maize and rubber. The competitiveness describes the performance of export growth as compared with other countries by improving upon it export shares in the world markets. A high values for competitiveness indicates an increase in the export shares in the world market.

Third, export diversification, DV_t, is estimated by using Gini-Hirschman formula following Authukorala (1991) and Al-Marhubi (2000):

$$DV_t = 100\sqrt{\sum_{i=1}^{n}\left(\frac{X_{it}}{\sum_{j=1}^{n} X_{jt}}\right)^2}$$

where X_{it} is the value of exports of commodity i at time t; i = rice, pulses, maize and rubber. DV_t is an inverse measure of diversification (i.e., concentration). The highest likely value is 100, which indicates that the total agricultural exports are comprised of only one commodity. When the number of goods exported increases, then the value of DV_t is lower. This means when the value of DV_t is lower, it indicates that export diversification has increased.

In the analysis, the marginal effects of WD_t and CM_t are expected to be positive. As DV_t is an inverse measure of diversification, we expect a negative sign for its coefficient. If the international market conditions have an overriding effect in controlling agricultural export performance, the world-export market potential should have a strong influence in explaining changes in real agricultural exports XV_t. On the other hand, if the local supply-side conditions have a strong influence, then the volume of real agricultural exports should be mainly explained by CM_t and DV_t . It is to be noted that CM_t and DV_t , supply-side policy variables used in the analysis can represent the influence of non-policy factors along with domestic policy. These non-policy aspects include: resource shifting from the agricultural sector due to industrialization, failure to extend cultivation, and limitations on diversification due to lack of new product lines. Nevertheless, the studies such as by Al-Marhubi (2000); dePineres and Ferrantino (1997) and Edwards (1993) have shown that domestic policies have a strong influence in gaining market share in traditional agricultural exports and export diversification as compared to the influence of non-policy factors. Based on the findings from the above-mentioned studies, it is expected that CM_t and DV_t would capture the effects of domestic policy on agricultural export performance.

For mapping the impact of domestic policies, however, we cannot use alternative representative variables for domestic policies due to conceptual and data difficulties. Generally, many aspects of the incentive to export cannot be evaluated directly (Riedel et al 1984). Moreover, other incentives such as infrastructure developments, research and development in agriculture and related areas play a significant role in determining performance. As a consequence demand effects in the model could be overestimated.

However, given the constraints, the present approach seems to be more appropriate to identify the effect of supply-side factors in terms of CM_t and DV_t on the agricultural export performance.

Necessary data were taken from CSO, DAP, DOA, FAO STAT, World Bank database and world integrated trade solution (WITS). In this analysis, the model was estimated using annual time series data for 21 years ranging from 1990 to 2010.

3.2.4.2 Gravity model analysis for export demand of rice

Gravity model is estimated in terms of logarithms form (*log*). Due to its log-log-linear structure, the coefficients of the gravity model are in terms of elasticity or ratio of percentage changes. The gravity model used in the case of Myanmar is anaalogous to the one utilized by Frankel(1997). The study uses the total export volume as dependent variable. The independent variables are GDP, GDP per capita, purchasing power parity, production, population, India's rice price, Vietnam's rice price and world rice price. GDP of importing economies is also considered to be an important variable for estimating export demand functions (Goldstein and Khan 1978).

Economic theory suggests that the price in the given exporting nation compared to other exporting nations and the translation of those prices to the importing nations would be important considerations. These prices, in combination with the population and purchasing power of the market, should explain the major variations in export demand for a product of a given nation. In the gravity model, Bangladesh and Indonesia are selected as importing countries because Myanmar exported rice to these countries yearly. And then, these countries are larger population, consumption and still poor condition. India and Vietnam are selected as competing countries with Myanmar because India and Vietnam are still larger exporter after Thailand in South East Asia.

Studying the flow of exports across countries provided valuable information to make inferences about trade trends of selling countries. Economic theory indicated that higher income elasticities of export demand caused exports to be a powerful engine of growth (Lord 1991). Also, higher price elasticities created a more competitive international market for the exports of a country. (Goldstein and Khan 1985; Lord 1991).

One idea to overcome one of these problems had been the theory that the economic growth of developing countries could be maintained by increasing trade among developing countries (Lewis, 1980). The dependence of developing countries on trade with other developing countries had not been thoroughly studied.

The relative export performance of a country depended on domestic supply and external demand conditions. The domestic supplies conditions affect export performance by upholding a country's ability to maintain its competitiveness in traditional products and by diversifying exports. In a given composition of traditional exports and its market shares, the export performance could be evaluated by analyzing relative export growth, the change in market shares of (traditional) agricultural exports, and the change in the commodity composition, (Authukorala 1991).

To determine the factors affecting the export demand of rice in Myanmar, the gravity model was used. The specific gravity model employed in this analysis is of the following form:

$$\log X = \alpha_1 + \alpha_2 \log(GDP) + \alpha_3 \log(GDP\ per\ capita) + \alpha_4 \log(PPP) + \alpha_5 \log(P) + \alpha_6 \log(Pop) + \alpha_7 \log(Pr_{india}) + \alpha_8 \log(Pr_{vietnam}) + \alpha_9 \log(Pr_{worldprice}) + e$$

Where,

X	=	export volume of Myanmar rice ($),
GDP	=	importing country's GDP
GDP per capita	=	importing country's GDP per capita
PPP	=	importing country's purchasing power parity
P	=	importing country's production
Pop	=	importing country's population
Pr_{india}	=	India's rice price
Pr_{viet}	=	Vietnam's rice price
$Pr_{worldprice}$	=	world rice price

For the export demand analysis, data were collected for Myanmar rice. The data on value of exports were collected from CSO, FAOSTAT, World Bank database, IMF and other related institutions.

This study would test to ensure that all variables included in the study are stationary either in levels or in first differences (unit root tests) and to look at the possibility of long-run relationships between the integrated variables (cointegration test).

3.2.4.3 Supply analysis of rice

Rice production has increased substantially throughout the years according to government published data. Government introduced summer paddy production program starting from 1992. It increased crop production intensification for farmers. Farmers who relied on rainy season can now grow second rice with irrigation within a year. Improved high yielding varieties were produced by Department of Research (DAR) and are transferred to seed division of Department of Agriculture (DOA) to reproduce mass scale. Although considerable efforts have been put into increasing yields in the country, adverse weather conditions in some years due to climate change, and low input use sill keep average yields lower than other neighboring countries. Rice production in any country is the result of producers' planting decisions in each year and can be represented mathematically as:

$$S_t = A_t * Y$$

where S is the quantity of rice produced, A is the rice area harvested, Y is the yield of rice per unit of area (acre or hectare), and t represents the current time period. The area harvested is a function of the area planted by producers as affected primarily by weather and possibly some economic variables. Likewise, yield is a function of weather but also of technical change. To calculate the quantity of rice supply can be defined as follows:

$$\mathbf{S_r = S_r (\bar{A}, Y)}$$

where, S_r = quantity of rice supply

$\bar{A}$ = rice sown area

Y = rice yield

From this equation, it could be obtained the price elasticity of output by summarizing the elasticity of area and elasticity of yield with respect to price. Rice sown area was depended on the following factors:

$$\mathbf{A_r = A_r (P_{t-r} , P_f, A_{t-1})}$$

where, A_r = rice sown area

P_{t-r} = lagged rice price of paddy

P_f = price of fertilizer

A_{t-1} = lagged rice sown area

The expected yield depended on the following factors:

$$\mathbf{Y_r = Y_r (P_{t-1}, P_f, MV)}$$

where, Y_r = the expected yield of rice

P_{t-1} = lagged price of rice

P_f = price of fertilizer

MV = area for modern and hybrid rice varieties

Empirical model of rice supply

Regression analysis was used to examine the area response and yield response functions. Area response function was as follows:

$$\log A_t = \alpha_0 + \alpha_1 \log P_{t-1} + \alpha_2 \log P_f + \alpha_3 \log A_{t-1} + \alpha_4 \log I + \alpha_5 \log HYV + \alpha_6 \log R + u_t$$

where A_t = rice sown area

P_{t-1} = lagged price of paddy

P_f = price of fertilizer

A_{t-1} = lagged sown area

I = Irrigated area

HYV = HYV area

R = Annual rainfall

u_t = disturbance term

Yield response function was as follows:

$$\log Y_t = \gamma_0 + \gamma_1 \log P_{t-1} + \gamma_2 \log P_f + \gamma_3 \log MV_t + \gamma_4 \log I + \gamma_5 \log HYV + \gamma_6 \log R + v_t$$

where Y_t = Yield

P_{t-1} = lagged price of paddy

P_f = price of fertilizer

MV_t = area of modern varieties and hybrid varieties

I = Irrigated area

HYV = HYV area

R = Annual rainfall

v_t = disturbance term

CHAPTER 4
FACTORS AFFECTING THE EXPORT VALUE OF MAJOR AGRICULTURAL COMMODITIES

The relative export performance of a country depends on domestic supply and external demand conditions. The domestic supply conditions affect export performance by upholding a country's ability to maintain its competitiveness in traditional products and by diversifying exports. In a given composition of traditional exports and its market shares, the export performance can be evaluated by analyzing:

- relative export growth,
- the change in market shares of (traditional) agricultural exports, and
- the change in the commodity composition,

(Authukorala 1991).

Studying the flow of exports across countries as a result of changes in relative prices in their international partners provides valuable information to make inferences about trade trends of selling countries.

4.1 General Conditions of Major Agricultural Export Commodities

Figure 4.1 showed the share of agricultural export commodities during 1990-2010. The share was 14.24% for rice, 64.85% for pulses, 3.52% for maize, and 4.7% for rubber respectively. The share was 0.32% for oilcake, 0.21% for raw cotton, 0.16% for raw jute and 12.35% for other agriculture products. Therefore, to analyze the export value of the major export commodity, the study selected rice, maize, pulses and rubber because share for these commodities were more than other commodities.

For this analysis, the annual time series covered the period from 1990 to 2010. All data sets are taken from a number of issues from different sources consisting Central Statistical Organization (CSO), Ministry of Agriculture and Irrigation, FAOSTAT, other source like FAO Trade Yearbook and World Bank Yearbook of Trade Statistics. The quantity of exports is in terms of metric ton (MT), whereas value of exports is in 1000 US$. In this chapter, it is composed of two main parts comprising a description of major export commodities and the results of the econometric analysis (unit roots, cointegration, and regression analysis).

4.1.1 Descriptive statistics of export values for major agriculutral commodities

Over 21 years, descriptive statistics of annual export values are presented in Table 4.1. Minimum export values of rice was 2.51 million US $ and maximum export values was 199.41 million US $. Minimum export values of maize was 2.73 million US $ and maximum export values was 31.06 million US $. Minimum export values of pulses was 60.68 million US $ and maximum export values was 729.68 million US $. Minimum export values of rubber was 0.48 million US $ and maximum export values was 35.31 million US $.

The export values averaged 41.34 million US $ for rice, 12.35 million US$ for maize, 290.24 million US$ for bean and 16.31 million US$ for rubber respectively.

4.1.2 Situation of annual export values of major agricultural commodities for various year

Export values of rice, maize, pulses and rubber were used to describe the economic performance of Myanmar. The condition and trend of annual export value of Myanmar for the period of 1990-2010, measured in thousand US$, is shown in Figure 4.2 (a to d). In these graphs it can be seen that export values were upward and downward trend. In terms of value, export values for rice and maize were fluctuated and that of pulses started to rise in 1990s and declined in 2010. In general, the value of export for pulse in Myanmar was trending upward. In case of rubber, rising trend was in 1990 and declined in 2007. After that, it was again rised in 2008 and declined in 2009 and 2010. These figures illustrated more or less similar trend in general view. In summary, during the observed periods, the export values of pulses were the highest, followed by rice, maize and rubber.

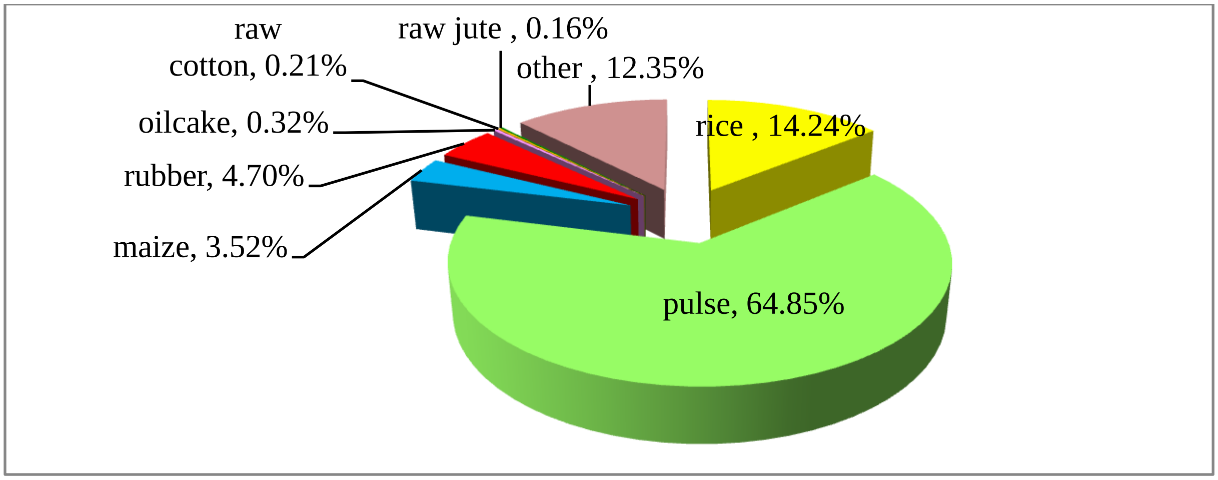

Figure 4.1 Share of agricultural export commodities in crop sector (1990 – 2010)

Table 4.1 Descriptive statistics of annual export values series (Million US $)

No.	Export Value Series	Minimum	Maximum	Mean	Std.Deviation
1.	Rice	2.51	199.41	41.34	47.88
2.	Maize	2.73	31.06	12.35	8.64
3.	Pulses	60.68	729.68	290.24	206.16
4.	Rubber	0.48	35.31	16.31	9.88

Note: Aannual data from 1990 to 2010, N=21

Data source: CSO, FAO STAT, Various years

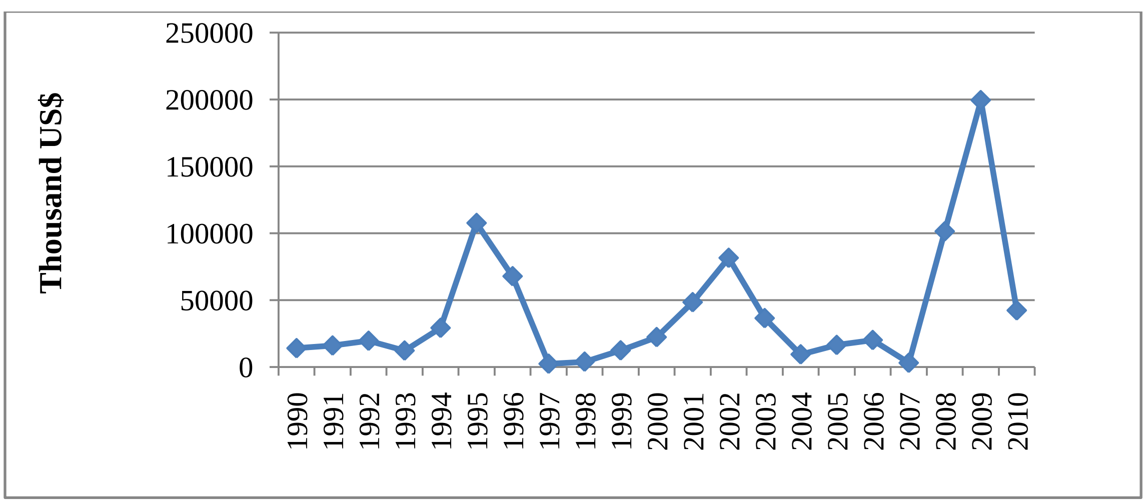

Figure 4.2.a Export value of Myanmar's rice (1990-2010)

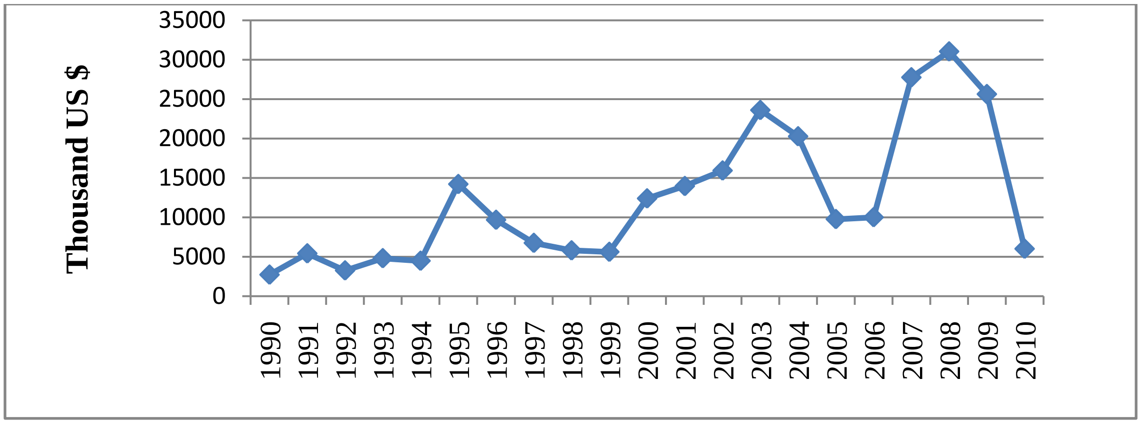

Figure 4.2.b Export value of Myanmar's maize (1990-2010)

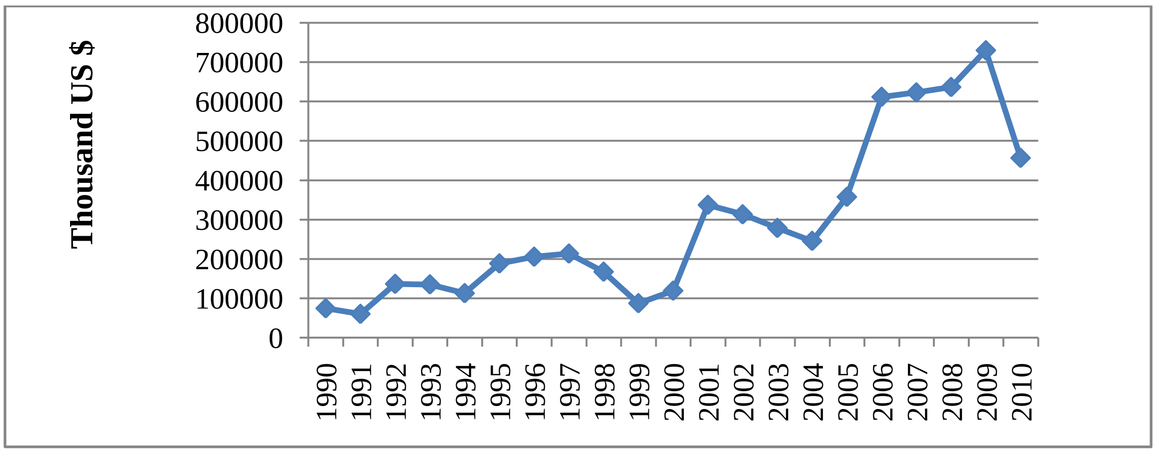

Figure 4.2.c Export value of Myanmar's pulses (1990-2010)

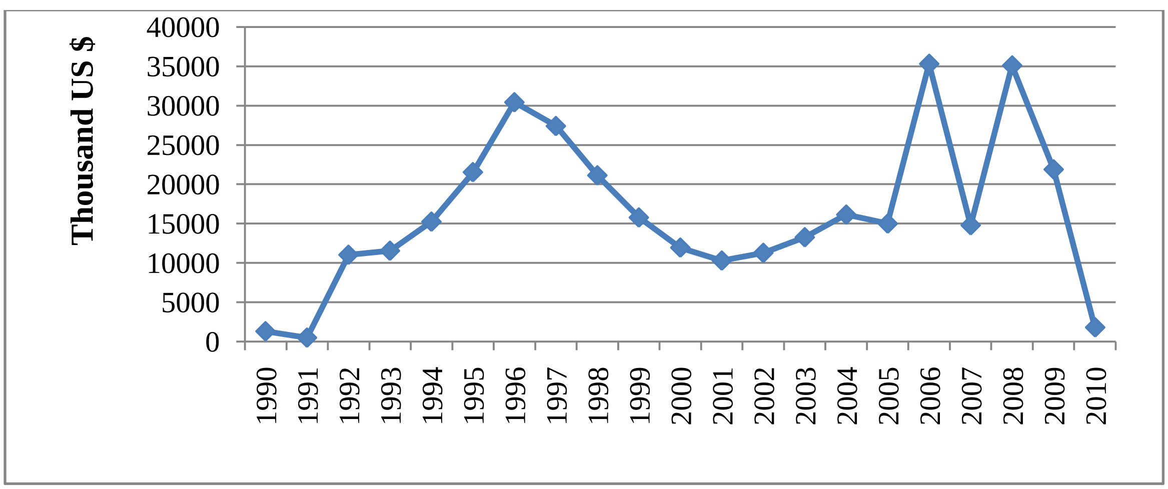

Figure 4.2.d Export value of Myanmar's rubber (1990-2010)

Figure 4.2 Situation of annual export value of Myanmar's rice, maize, pulses and rubber (1990-2010)

Source: CSO, FAOSTAT, Various years

4.2 Descriptive statistics

4.2.1 Descriptive statistics on aggregate agricultural export values, export diversification, world demand and competitiveness of Myanmar (1990 – 2010)

Four indicators used in the study such as export value, world demand, competitiveness and export diversification over 21 years were taken to describe the economic performance of Myanmar. Descriptive statistics of those indicators were presented in Table 4.2. Minimum agricultural export values was 82.71 million US $ and maximum was 976.62 million US $. On average, it was 360.22 million US$. In case of export diversification, minimum was 65.88 and maximum was 93.27 while the mean value was 80.85. When we looked at the world demand, minimum was 7.34 million US$ and maximum was 20.79 million US $. On average, it was 11.18 million US$. In competitiveness for major agricultural export commodities, the mean value was 0.12 meaning that less competitive with external market in which minimum was 0.08 and maximum was 0.19.

4.2.2 Situation on aggregate agricultural export values, export diversification, world demand and competitiveness of major agricultural export commodities (1990 – 2010)

Figures 4.3 (a to d) represented the trend in these four indicators for export contition and competitivenss with external market for Myanmar during the period 1990-2010. In these graphs it can be seen that aggregate export value was upward trend during 1990 to 2009. After that, it was again declined in 2010. In graph of export diversification, diversification value showed much meaning that less diversification occurred. The trend of aggregate world demand showed stable. It started to rise from 2006 to 2008. World demand was the highest in 2008 and declined after that period. Competitivenss of major agricultural export commodities for Myanmar was trending downward meaning less competitiveness with external market.

Table 4.2 Descriptive statistics of export value, world demand, competitiveness and diversification

No.	Indicators	Unit	Minimum	Maximum	Mean	Std.Deviation
1.	Export value	Million US$	82.71	976.62	360.23	245333.26
2.	Export diversification	%	65.88	93.27	80.85	7.26
3	World demand	Million US$	7.34	20.79	11.18	3557.95
4.	Competitiveness	-	0.08	0.19	0.12	0.04

Note: Annual data from 1990 to 2010. N=21

Data source: CSO, FAOSTAT, Various years

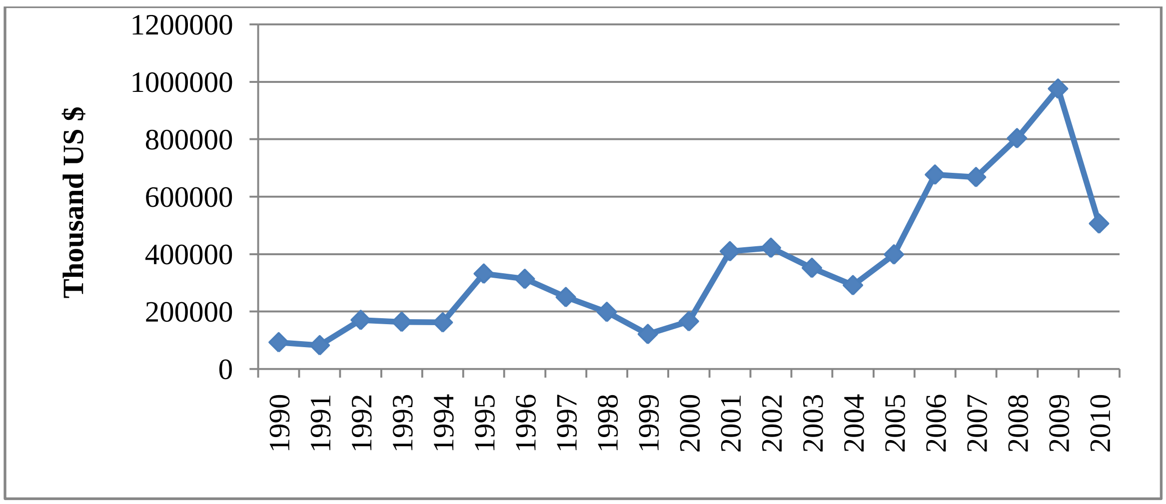

Figure 4.3.a Aggregate agricultural export value of major export commodities for Myanmar (1990-2010)

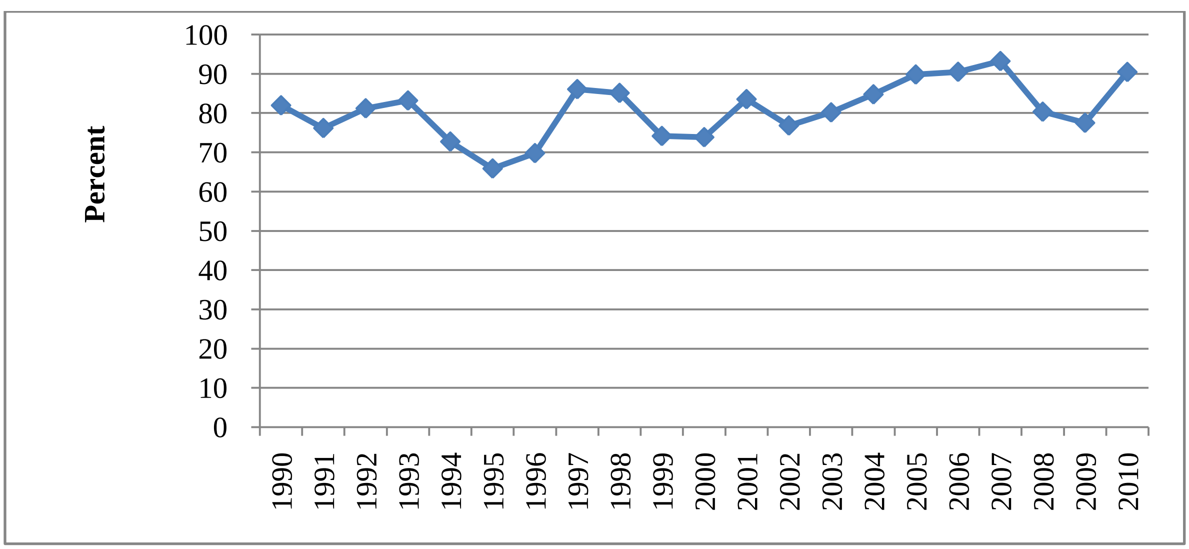

Figure4.3.b Export diversification on major agriultural export commodities (1990 -2010)

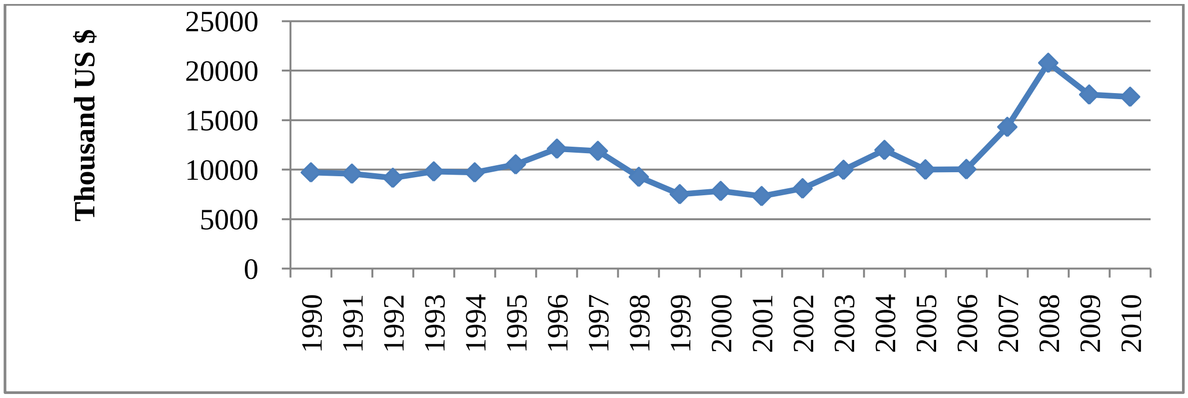

Figure 4.3.c World demand of major agriultural export commodities (1990 -2010)

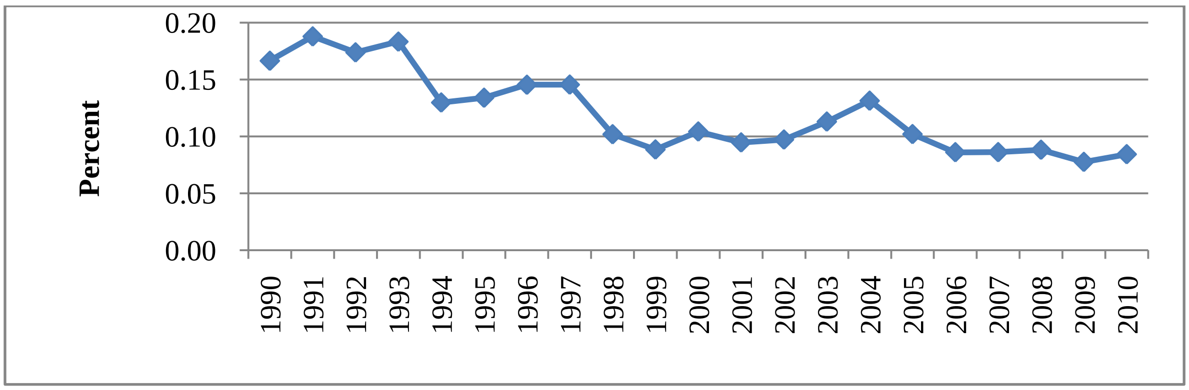

Figure 4.3.d Competitiveness of major agriultural export commodities (1990 -2010)

Figure 4.3 Situation on aggregate agricultural export values, export diversification, world demand and competitiveness of major agricultural export commodities (1990 – 2010)

4.3 Econometric Results for Aggregate Agricultural Export Values, Export Diversification, World Demand and Competitiveness of Major Agricultural Export Commodities

4.3.1 Unit root test

The vector of variables used in estimation of equation included agricultural export value, export diversification, world demand and competitiveness in logarithm form. All variables were tested for the presence of unit roots, using the Augmented Dickey-Fuller unit root testing procedure. Results were reported in Table 4.3. At the 95% significant level, the null hypothesis of unit root is not rejected for all variables indicating that all time series are non stationary. The data series was used in the first-difference form. The first difference of the variables was examined and the hypothesis of unit root is rejected. Thus, all variables are integrated of order one I (1).

The ADF statistic value of level form for *log*XV was -1.76. In addition, the critical values at 1%, 5% and 10% levels were -3.81, -3.02 and -2.65. The statistic t_{α} value was greater than the critical values so that we did not reject the null hypothesis. The ADF test statistic value had a probability value of 0.39, providing evidence that we might not reject the null hypothesis of a unit root. This indicated that it had a unit root (Appendix1). The ADF statistic value of first difference level for *log*XV was -3.93. In addition, the critical values at 1%, 5% and 10% levels were -3.92, -3.07 and -2.67. The statistic t_{α} value was smaller than the critical values so that we must reject the null hypothesis. The ADF test statistic value had a probability value of 0.00, providing that we might reject the null hypothesis of a unit root. This indicated that it did not have a unit root and it had non-stationary (Appendix 2).

The ADF statistic value of level form for *log*DV was -1.26. In addition, the critical values at the 1%, 5% and 10% levels were -3.86,-3.04 and -2.66. The statistic t_{α} value was greater than the critical values so that we did not reject the null hypothesis. The ADF test statistic value had a probability value of 0.62, providing evidence that we might not reject the null hypothesis of a unit root. This indicated that it had a unit root (Appendix 3). The ADF statistic value of first difference level for *log*DV was -5.67. In addition, the critical values at 1%, 5% and 10% levels were -3.86, -3.04 and -2.66. The statistic t_{α} value was smaller than the critical values so that we must reject the null hypothesis. The ADF test statistic value had a probability value of 0.00, showing that we might reject the null hypothesis of a unit root. This indicated that it did not have a unit root and it was non-stationary (Appendix 4).

The ADF statistic value of level form for *log*WD was -0.78. In addition, the critical values at 1%, 5% and 10% levels were -3.81, -3.021 and -2.65. The statistic t_α value is greater than the critical values so that we did not reject the null hypothesis. The ADF test statistic value had a probability value of 0.80, providing evidence that we might not reject the null hypothesis of a unit root. This indicated that it had a unit root (Appendix 5). The ADF statistic value of first difference level for *log*WD was -4.06. In addition, the critical values at 1%, 5% and 10% levels were -3.86, -3.04 and -2.66. The statistic t_α value was smaller than the critical values so that we must reject the null hypothesis. The ADF test statistic value had a probability value of 0.00, indicating that we might reject the null hypothesis of a unit root. This indicated that it did not have a unit root and it was non-stationary (Appendix 6).

The ADF statistic value of level form for *log*CM was -1.35. In addition, the critical values at 1%, 5% and 10% levels were -3.81, -3.02 and -2.65. The statistic t_α value was greater than the critical values so that we did not reject the null hypothesis. The ADF test statistic value had a probability value of 0.58, providing evidence that we might not reject the null hypothesis of a unit root. This indicated that it had a unit root (Appendix 7). The ADF statistic value of first difference level for *log*CM was -4.24. In addition, the critical values at 1%, 5% and 10% levels were -3.86, -3.04 and -2.66. The statistic t_α value was smaller than the critical values so that we must reject the null hypothesis. The ADF test statistic value had a probability value of 0.00, providing that we might reject the null hypothesis of a unit root. This indicated that it did not have a unit root and it was non-stationary (Appendix 8).

4.3.2 Cointegration test

After testing the ADF, this study traced out whether data series are in co-integration or non co-integration by using Unrestricted Cointegration rank test (Table 4.4). Cointegration required the variables to be integrated of the same order. This trace test clearly indicated that there is no co-integration at the 5% level.

All variables become stationary at 5% level of significance.The co-integration relation among variables was checked using the cointegration technique proposed by Johansen and Juselius (1990) to identify long-term equilibrium relation(s) among the variables. The economic interpretation of co-integration was that if two (or more) series were linked to form an equilibrium relationship spanning the long-run, then even though the series themselves may contain stochastic trends (i.e, be non-stationary) they will nevertheless move closely together over time and the difference between them will be stable (i.e., stationary).

The result of the cointegration condition (that is the existence of a long term linear relation) was presented in Table 4.4 (Trace Statistics) and 4.5 (Maximum Eigenvalue) using methodology proposed by Johansen and Juselius (1990). The values of computed (λ trace) and (λ max) statistics were found to be less than the critical values as shown in Table 4.4 and 4.5. Therefore, both the (λ trace) and (λ max) statistics supported the hypothesis of no cointegration among the variables. In the cointegration tables, both trace statistic and maximum eigenvalue statistic indicated no cointegration at the 5 percent level of significance, suggesting that there was no cointegration (or long run) relationship. Since the null hypothesis was accepted, there was no need to further subject the variables to error correction test.

Table 4.3 Unit root tests (Augmented Dickey-Fuller, ADF test)

Variables	ADF Test(level form)		ADF Test(first difference)		Order of integration
	Test statistics	Probability	Test statistics	Probability	
*log*XV	-1.76	0.3901	-3.92	0.0099	I(1)
*log*DV	-1.26	0.6234	-5.67	0.0003	I(1)
*log*WD	-0.78	0.8019	-4.06	0.0066	I(1)
*log*CM	-1.35	0.5840	-4.24	0.0045	I(1)

Note: Augmented Dicky-Fuller (ADF) test the hypothesis of $H_0 : \beta = 0$ vs $H_1 : \beta < 0$. ADF analysis was carried out in EVIEWS©5.

Sources: CSO, FAOSTAT, World Bank, Various years

Table 4.4 Unrestricted cointegration rank test (trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value (0.05)	Prob.**
None	0.626850	36.90538	47.85613	0.3520
At most 1	0.462668	17.18986	29.79707	0.6260
At most 2	0.201596	4.767062	15.49471	0.8330
At most 3	0.013125	0.264245	3.841466	0.6072

Trace test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 4.5 Unrestricted cointegration rank test (maximum eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	Critical Value (0.05)	Prob.**
None	0.626850	19.71552	27.58434	0.3611
At most 1	0.462668	12.42280	21.13162	0.5065
At most 2	0.201596	4.502817	14.26460	0.8028
At most 3	0.013125	0.264245	3.841466	0.6072

Max-eigenvalue test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

4.3.3 Results of Ordinary Least Square Method

After finding that there was no co-integration, the model was estimated by ordinary least square method. The regression results using the variables such as aggregate agricultural export values, export diversification, world demand and competitiveness were illustrated in Table 4.6. The estimated coefficients were taken as elasticities since all variables have been used in logarithmic form. In regression reults, R^2 value was 0.71 meaning that 71% of the total deviation was explained by the regression.

The estimated coefficient for world demand kept the expected sign and statistically significant at 1% level. It meant if world demand for agricultural export commodities was increased by 1%, the export value of these commodities will be increased by 1.09%. Coefficient for the competitiveness had expected sign and was significant at 1% level. It meant that if competitiveness was increased by 1%, the export value would be increased by 1.43%.

It can be stated that world demand for export commodities and competitiveness play crucial role in determining the export performance of Myanmar. Athukorala (1991) reported that export prospects for agricultural products are considered to be determined predominantly by the long-term pattern of world demand leaving little room for supply side factors to achieve export success.

Among the vairables, the coefficient of diversification was not statistically significant meaning that whatever the diversification was, export value of agricultural commodities was not affected in this study. But in some cases, there exists a potential to diversify the export products in the supply side by improving the factors such as market promotion, infrastructure investment and productivity increases in terms of horizontal and vertical diversification.

In conclusion, world demand and competitivenss for major agricultural export commodities were important role in determining the export performanc of Myanmar where major export items were rice, maize pulses and rubber. Out of these items, priority given for Myanmar was rice and pulses. Based on the Figure (4.4) and (4.5), world demand as well as competitivensess was found to be higher in pulses than in rice. However, the question was why we are lagging behind in export of rice compared to other rice exporting countries even though Myanmar stood as top rice exporter before the Second World War. Moreover, rice is economically and politically important crop, to provide sufficient supply for domestic consumption for increasing population and to enhance income generation of rural majority of pupulation relying on rice production.

Table 4.6 Determinants of export value of major agricultural commodities (1990 – 2010)

Independent Variables	**Coefficient**	**Standard Deviation**	**Probability**
Constant	-2.48	4.96	0.62
World Demand	1.09***	1.06	0.00
Competitiveness	1.43***	0.34	0.00
Diversification	0.42	0.35	0.69
R-squared	0.71		
Adjusted R-squared	0.66		
No. of observation	21		
Sum squared residual	2.83		
F-statistic	13.77		
Probability (F- statistics)	0.00		

* denotes significant at 1% level. ** denotes significant at 5% level. *** denotes significant at 10% level.

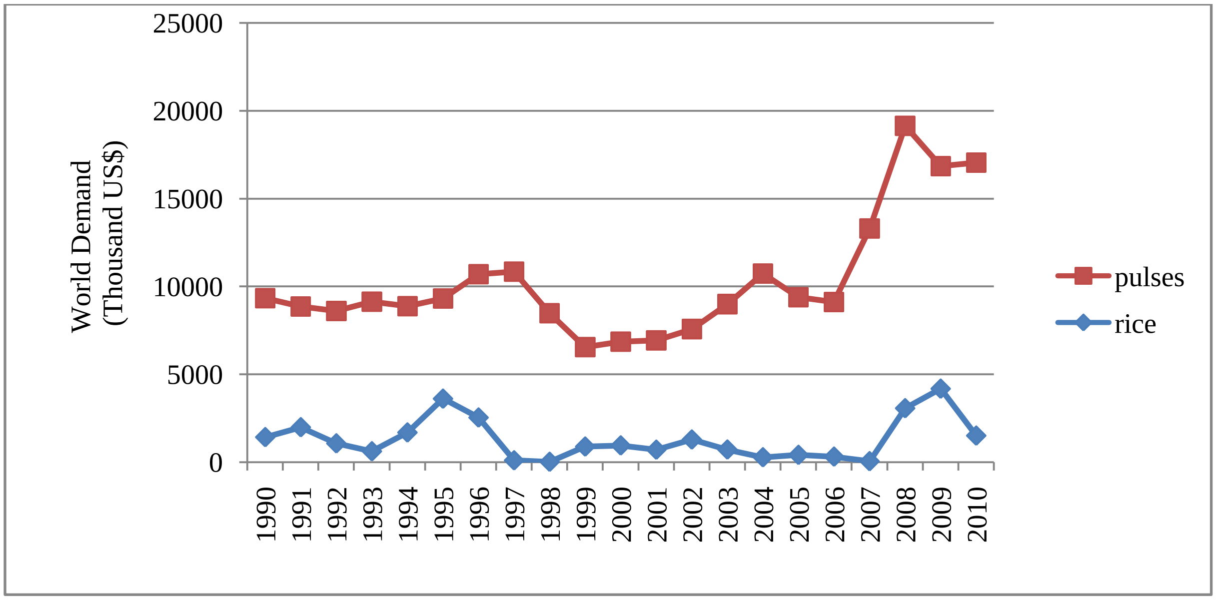

Figure 4.4 World demands of rice and pulses (1990-2010)

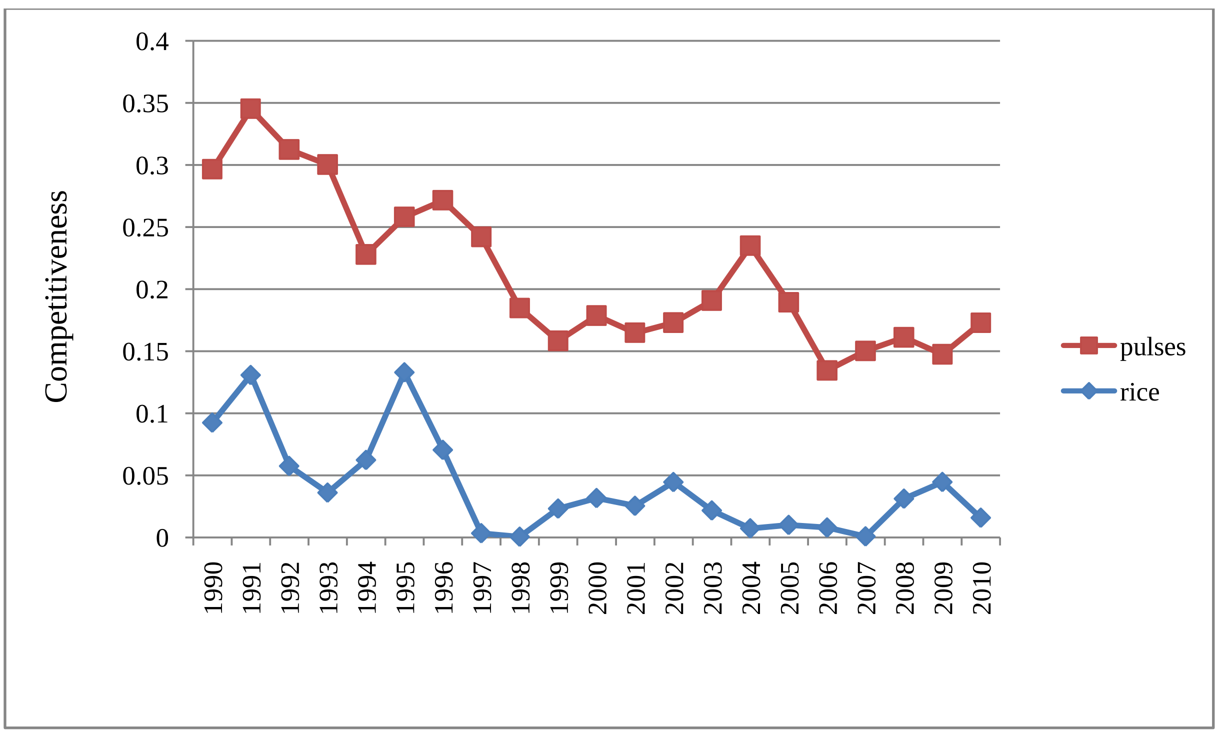

Figure 4.5 Competitiveness of rice and pulses (1990-2010)

CHAPTER 5

EXPORT DEMAND ANALYSIS FOR MYANMAR RICE EXPORT

5.1 Data Employed in Export Demand Analysis of Rice

Dependent Variable employed in gravity model of rice was volume of export in logarithum form over 21 years from 1990 to 2010 and data was obtained from Central Statistical Organization. The independent variables were GDP, GDP per capita, purchasing power parity, population, production of importing countries namely Bangladesh and Indonesia, price of competing countries namely India and Vietnam and world rice price.

5.2 Results of Gravity Model for Export Demand of Myanmar Rice

5.2.1 Gravity model results for Bangladesh

As explained in the chapter (3) of research methodology, three models were analyzed to understand the export demand of Myanmar rice in relation to trading partners namely Bangladesh and Indonesia. The estimation results for these models were reported in Table 5.1. In Model (1), R^2 value was 0.58. This meant that 58% information of the total deviation was explained by the regression indicating that the phenomenon was significant between explaining variables and dependent variables. In Model (2) and (3), R^2 value was 0.55 and 0.57 meaning that 55% and 57% of the total deviation were explained by the regression.

The coefficient of GDP for Bangladesh was found to be significant and the sign was negative. The results demostrated that if GDP of Bangladesh increased by 1%, Myanmar’s rice export was decreased by 5.08%. This finding was consistent with the result of Idsardi, E. (2010) who proved that the determinants of agricultural export growth in South Africa using the variables of trading partners’ GDP were found to be significant and the signs for durum wheat, cereal pellets and sunflower seeds were negative. Importing rice volume and GDP of Bangladesh was shown in Table 5.2. In 2005-2006 and 2009-2010, the exported amount of rice for Myanmar declined even though GDP of Bangladesh was increased. Bangladesh did not import Myanmar’s rice in 2007.

We also included the variable of GDP per capita of Bangladesh. It is expected that the higher the income per capita for Bangladesh, the greater the demand for imports. In Model (1), (2) and (3), the coefficient of Bangladesh’s GDP per capita was highly significant at 1%

level and the sign of the coefficient was positive. This indicated that if GDP per capita of Bangladesh increased by 1%, Myanmar rice export will be increased by 2.71%, 2.81% and 2.56% respectively in each model. This suggested that GDP per capita for importing country had significant impact on exports. These results also pointed out that rise in GDP per capita of Bangladesh can affect the increase in rice export of Myanmar where the quality of exported rice was 25% broken.

In Table 5.3, when we checked the income of the people of Bangladesh, it was shown that the difference between average income of rural and urban people was slightly high. In 2010, the average income was 16477 Taka (236.57 US$) for urban household and 9648 Taka (138.52 US$) for rural household. In 2005, the average income of urban household was 10463 Taka (162.65 US$) and that of rural household was 6096 Taka (94.76 US$). At national level, the average income rose from 7203 Taka (111.97 US$) in 2005 to 11480 Taka (164.83 US$) in 2010. In 2000, the average income of urban household was 9878 Taka (189.44 US$) and that of rural household was 4816 Taka (92.36 US$) whereas in 1996, 7973 Taka (190.77 US$) for urban household and 3658 Taka (87.52 US$) for rural household respectively. In Table 5.3, even though average income level of Bangladesh increased slightly year after year, the income gap between urban and rural household was large in some extent in which about 70% of the total population resides in rural areas. Therefore, Bangladesh is still in poor condition. In Bangladesh, there are no quantitative restrictions on rice imports which are currently duty free. (Grain and Feed Annual Report of Bangladesh, 2013).

The elasticity of competing country's (India) rice price was statistically significant and had negative sign in each model. These results pointed out that when India's rice price decreased by 1%, Myanmar's rice export will be increased by 3.47%, 4.01% and 3.56% respectively in each model. The government of India allowed the minimum price for export where if export price was lower than minimum export price, no varieties were allowed to export to other country. The export price of Myanmar's rice was low due to poor quality in comparison with other exporters in the region. Therefore, when price of India's rice increased, Bangladesh will import Myanmar's rice with low export price which in turn reflected on increase in rice export of Myanmar.

Table 5.4 showed the annual export price of rice in terms of US$ for Myanmar and competing countries. At present, the export price of 25 percent broken rice for Myanmar was lower than that for India and Vietnam. If increase in export price for India and Vietnam

Table 5.1 Gravity model results of export demand of Myanmar rice with Bangladesh

Variables	**Model 1**	**Model 2**	**Model 3**
GDP	-5.08*	-4.03*	-5.20*
GDP per capita	2.71**	2.81**	2.56***
PPP	-0.91 ns	-2.42 ns	1.13 ns
POP	-7.70 ns	-6.73 ns	-6.67 ns
Production	-2.61 ns	-1.38 ns	-2.52 ns
Pr_{india}	-3.47*	-4.01**	-3.56**
$Pr_{vietnam}$	-0.58 ns	-0.95 ns	
$Pr_{worldprice}$	-1.36 ns		-1.42 ns
Observation	21	21	21
R squared	0.58	0.55	0.57
Adjusted R^2	0.30	0.31	0.35
Durbin-Watson stat	2.31	2.16	2.32
F statistic	2.07	2.30	2.54
P value	0.12	0.09	0.06

Notes: ***/**/* significant at 1%, 5%, and 10% level.

Table 5.2 GDP, the total amount of rice import, the amount of rice import from Myanmar for Bangladesh (1990-2010)

Year	Gross Domestic Product of Bangladesh ( )	Importing rice of Bangladesh(MT)	Myanmar rice to Bangladesh (MT)	Share of import for Myanmar (%)
1990-91	80.86	15801	0	0.00
1991-92	84.67	17724	0	0.00
1992-93	86	20865	0	0.00
1993-94	87.78	62578	0	0.00
1994-95	92.73	995946	33000	3.30
1995-96	98.02	1038199	20000	1.90
1996-97	101.59	179444	0	0.00
1997-98	105.88	1127208	12000	1.06
1998-99	111.12	215322	11000	5.11
1999-00	114.67	452122	17000	3.76
2000-01	116.63	352130	174000	49.00
2001-02	119.45	943433	47000	4.98
2002-03	124.1	1250712	29000	2.32
2003-04	129.54	991810	39000	3.90
2004-05	135.6	709378	39000	5.49
2005-06	142.56	577064	**12000**	2.08
2006-07	151.15	1328310	0	0.00
2007-08	163.01	789459	193000	24.45
2008-09	175.34	680000	202000	29.70
2009-10	186.74	656847	**10000**	15.22

Source: FAOSTAT, CSO, Various years

Table 5.3 Monthly household nominal incomes by residence

Year	Residence	Income (Taka)	Percentage of total population
2010	National	11480	
	Rural	9648	72.11
	Urban	16477	27.89
2005	National	7203	
	Rural	6096	74.36
	Urban	10463	25.64
2000	National	5842	
	Rural	4816	76.41
	Urban	9878	23.59
1995-96	National	4366	
	Rural	3658	77.93
	Urban	7973	22.07

Source: Household income and expenditure survey 2010, Bangladesh Bureau of Statistics

Table 5.4 Average rice prices (US$/MT) of 25%broken for different countries from 1990 to 2010

Year	25% Broken Rice (Myanmar) (US$/MT)	25% Broken Rice (India) (US$/MT)	25% Broken Rice (Vietnam) (US$/MT)
1990	186.00	232.72	230.00
1991	199.00	295.37	225.00
1992	181.00	265.51	211.00
1993	147.00	255.01	218.00
1994	163.00	227.00	243.00
1995	178.00	232.90	236.00
1996	194.00	270.02	233.00
1997	197.00	290.00	239.00
1998	199.00	278.00	232.00
1999	169.00	263.00	180.00
2000	151.00	232.00	159.00
2001	139.00	185.00	148.00
2002	128.00	140.00	168.00
2003	257.21	163.00	195.00
2004	270.00	284.00	229.00
2005	252.41	236.00	239.00
2006	257.46	247.00	273.00
2007	271.50	292.00	316.00
2008	274.11	345.00	350.00
2009	277.31	385.00	384.00
2010	282.79	390.00	387.00

Source: FAOSTAT, Various years

occurs, demands for importing countries (Bangladesh and Indonesia) will decline because of substitution and income effect. Substitution effect explains consumer behavior when increasing price occurs. It can be a chance for Myanmar's rice when there is increase in export price of two competing countries (India and Vietnam). However, it needs to consider the substainable market for Myanmar rice for which the quality of rice should be improved. In order to get high quality of rice, rice breeding program or selection of good quality traditional rice varieties or introduction of improved or hybrid varieties have to be done.

5.2.2 Gravity model results of export demand of Myanmar rice with Indonesia

The estimation results for model 1, 2 and 3 were reported in Table 5.5. Among the models, model (1) showed R^2 value of 0.55 meaning that 55% of total deviation was explained by the regression. In Model (2) and (3), R^2 value was 0.53 and 0.54 meaning that 53% and 54% of the total deviation were explained by the regression.

The coefficient of Indonesia's GDP was statistically significant at 1% level in model (1) and 10% level in model (3) respectively and the signs were positive. This meant that GDP of Indonesia increased by 1%, Myanmar's rice export will be increased by 2.65 percent and 2.52 percent repectively. This result was consistent with the basic assumption of the gravity model mentioning that the trade volumes would increase with an increase in economic size. In Model (2), although model showed the positive sign of the coefficient of the importer's GDP, it is not statistically significant.

We also included variable of GDP per capita of Indonesia. In all the three estimated models, the coefficient of importer's GDP per capita was statistically significant and the signs were positive. This indicated that an increase in the GDP per capita of the importing country resulted increase in export of rice for Myanmar. It can be interpreted that if GDP per capita of Indonesia increased by 1%, Myanmar rice export will be increased by 2.68%, 2.67% and 2.75% respectively.

Table 5.5 showed the percentage of rural population and urban population. Indonesia is the 4th most populous country in the world with a population of roughly 240 million people in which with recent population growth over 50 percent of the population lives in rural areas. Indonesia became a net rice importer since 1988. However, the government of Indonesia restricts imports of rice one month prior to, during, and two months after the main harvest period. (Grain and Feed Annual Report of Indonesia, 2011). On the other hand, Indonesian government gave more flexibility to BULOG to import rice using the poor program having the stock for rice. In 2011-12, BULOG distributed rice to 17.5 million poor families receiving 15 kg of rice in a month for each family.

The coefficient of production of importing country was statistically significant at 10% level in model (1) and 5% level in model (2) and (3) respectively. The sign was negative. This result pointed out that when Indonesia's rice production increased by 1%, Myanmar's rice export will be decreased by 1.64%, 1.32% and 1.93% respectively.

The elasticity of competing country (India)'s rice price was statistically significant and had negative sign in each model. This result pointed out that when India's rice price increased by 1%, Myanmar's rice export will be decreased by 2.9%, 2.99% and 2.77% respectively. The government of India allowed the minimum price for export where if export price is lower than minimum export price, no varieties were allowed to export to other country. The export price of Myanmar's rice was low due to poor quality in comparison with other exporters in the region. Therefore, when price of India's rice increased, Indonesia will import Myanmar's rice with low export price which in turn reflected on increase in rice export of Myanmar.

Based on the findings of two gravity models, the study pointed out that Myanmar will have comparative advantage if the export price of rice in competing countries rose. However, it needs to reflect on the substainable market for Myanmar rice for which the quality of rice should be improved. In order to get high quality of rice, rice breeding program or selection of good quality traditional rice varieties or introduction of improved or hybrid varieties have to be done.

Table 5.5 Gravity model results of export demand of Myanmar rice with Indonesia

Variables	**Model 1**	**Model 2**	**Model 3**
GDP	2.65***	4.00 ns	2.52*
GDP per capita	2.68***	2.67***	2.75***
PPP	7.06 ns	11.07 ns	6.78 ns
POP	-1.82ns	-6.73 ns	-6.33 ns
Production	-1.64*	-1.32 **	-1.93 **
Pr_{india}	-2.90***	-2.99***	-2.77***
$Pr_{vietnam}$	0.24ns	0.47 ns	
$Pr_{worldprice}$	-1.03ns		-1.06 ns
Observation	21	21	21
R squared	0.55	0.53	0.54
Adjusted R^2	0.34	0.33	0.35
Durbin-Watson stat	2.18	2.11	2.19

Notes: ***/**/* significant at 1%, 5%, and 10% level.

Table 5.6 Percentage of rural and urban population for Indonesia (1990-2010)

Year	Rural population (% of total population)	Urban population (% of total)
1990	69.42	30.58
1991	68.42	31.58
1992	67.43	32.57
1993	66.43	33.57
1994	65.44	34.56
1995	64.45	35.55
1996	63.16	36.84
1997	61.87	38.13
1998	60.58	39.43
1999	59.29	40.71
2000	57.99	42.00
2001	57.21	42.79
2002	56.42	43.58
2003	55.64	44.36
2004	54.85	45.15
2005	54.06	45.94
2006	53.27	46.73
2007	52.47	47.53
2008	51.67	48.33
2009	50.87	49.13
2010	50.08	49.92

Source: World Bank database

CHAPTER 6
INTERNAL SUPPLY ANALYSIS OF RICE

6.1 Description of Time Series Data on Rice Supply

The time series data of paddy production, sown area, paddy price, irrigated area, HYV area, urea price and annual rainfall were taken from Department of Agriculture, Department of Agricultural Planning and Ministry of Agriculture and Irrigation. The models were estimated by the ordinary least squares method. The dependent variable was total sown area for area response function and total production for yeild production function. For area response function, the independent variables were lagged paddy price, irrigated area, HYV area, urea price, lagged sown area and annual rainfall. For yeild response function, the independent variables were lagged paddy price, irrigated area, HYV area, price of urea, lagged sown area and annual rainfall.

To estimate the internal supply analysis, area response function and yield response function were conducted accordingly. The composition of following sections included two parts in which descriptive statistics and econometric analysis (unit roots, co-integration, and regression analysis) of area response and yield response function were conducted.

6.2 Descriptive statistics of area response and yield response function for rice

Descriptive statistics for area and yield response function were presented in Table 6.1. Over 21 years, minimum sown area was 4834 thousand hectare and maximum sown area was 8125 thousand hectare. The minimum value was 2344 kyats/MT and maximum was 141218 kyats/MT for lagged paddy price. For irrigated area, the minimum was 835 thousand hectare and maximum was 2329 thousand hectare. In case of HYV area, minimum was 2441 thousand hectare and maximum was 4956 thousand hectare. The minimum value was 235 kyats/bag and maximum was 31500 kyats/bag for price of urea. The minimum was 4666 thousand hectare and maximum was 8124 thousand hectare for lagged sown area. Minimum annual rainfall was 1709 millimeter and maximum annual rainfall was 2552 millimeter. Minimum production was 13201 million metric ton and maximum production was 32681 million metric ton.

The average sown area of rice was 6454 thousand hectare. The mean value for lagged paddy price was about 40538 kyats/MT while mean values were 1748 thousand hectare for irrigated area, 3796 thousand hectare for HYVgrowing area, 10568 kyats/bag for fertilizer price, 6284 thousand hectare for lagged sown area, 2289 millimeter for annual rainfall and 21774 million MT for total production respectively.

6.3 Econometric Results for Area Response and Yield Response Function for Rice

6.3.1 Unit root test

The variables used in estimation of area response function included logarithm form of sown area, lagged paddy price, irrigation area, HYV area, urea price, and lagged sown area and annual rainfall. Similarly, yield response function was considered as a function of total production, lagged paddy price, fertilizer price, irrigated area, annual rainfall, HYV area and total sown area, all in logarithm form. All variables were tested for the presence of unit roots, using the Augmented Dickey-Fuller unit root testing procedure. Results were reported in Table 6.2. At the 95% significant level, the null hypothesis of unit root was not rejected for all variables indicating that all time series were non stationary. The first difference of the variables was examined and the hypothesis of unit root was rejected. Thus, all variables were integrated of order one I (1).

The ADF statistic value of level form for log of sown area was -0.73. In addition, the critical values at 1%, 5% and 10% levels were -3.83, -3.03 and -2.66. The statistic t_α value was greater than the critical values so that we did not reject the null hypothesis. The ADF test statistic value had a probability value of 0.82, providing evidence that we might not reject the null hypothesis of a unit root. This indicated that it had a unit root (Appendix 9).The ADF statistic value of first difference level for log of sown area was -3.95. In addition, the critical values at 1%, 5% and 10% levels were -3.92, -3.07 and -2.67. The statistic t_α value was smaller than the critical values so that we must reject the null hypothesis. The ADF test statistic value had a probability value of 0.00, providing evidence that we might reject the null hypothesis of a unit root. This indicated that it did not have a unit root and it had stationary (Appendix 10).

Table 6.1 Descriptive statistics of area response and yield response variables for rice

No.	Export Value Series	Unit	Minimum	Maximum	Mean	Std.Deviation
1.	Sown area	'000ha	4834	8125	6454	1046
2.	Lagged paddy price	kyat/MT	2344	141218	40538	45101
3.	Irrigated area	'000ha	835	2329	1748	456
4.	HYV area	'000ha	2441	4956	3796	755
5.	Urea price	kyat/bag	235	31500	10568	10030
6.	Lagged sown area	'000ha	4666	8124	6284	1046
7.	Annual rainfall	millimeter	1709	2552	2289	204
8.	Total production	Million MT	13201	32681	21774	6371

Note: Annual data from 1990 to 2010. N=1
Data source: DAP, DOA, Various years

Table 6.2 Results of ADF unit root test

Variable	ADF (level form)		ADF (First difference)		Order of integration
	Test Statistics	Probability	Test Statistics	Probability	
log(sown area)	-0.73	0.82	-3.95	0.00	I(1)
log (lagged paddy price)	-0.12	0.93	-5.12	0.00	I(1)
log (irrigated area)	-2.59	0.12	-3.72	0.01	I(1)
log (HYV area)	-2.17	0.22	-3.50	0.02	I(1)
log (urea price)	-1.78	0.38	-4.65	0.00	I(1)
log (lagged sown area)	-0.75	0.81	-3.65	0.01	I(1)
log (annual rainfall)	-4.08	0.01	-7.57	0.00	I(1)
log (total production)	1.78	0.99	-3.44	0.02	I(1)

Note: 1. Augmented Dicky-Fuller (ADF) test the hypothesis of $H_0 : \beta = 0$ vs $H_1 : \beta < 0$. ADF analysis was carried out in EVIEWS©5.

Sources: DAP, DOA, CSO, Various years

The ADF statistic value of level form for log of lagged paddy price was -0.12. In addition, the critical values at 1%, 5% and 10% levels were -3.83, -3.03 and -2.66. The statistic t_α value was greater than the critical values so that we did not reject the null hypothesis. The ADF test statistic value had a probability value of 0.93, providing evidence that we might not reject the null hypothesis of a unit root. This indicated that it had a unit root (Appendix 11). The ADF statistic value of first difference level for log of lagged paddy price was -5.12. In addition, the critical values at 1%, 5% and 10% levels were -4.00, -3.10 and -2.69. The statistic t_α value was smaller than the critical values so that we must reject the null hypothesis. The ADF test statistic value had a probability value of 0.00, providing evidence that we might reject the null hypothesis of a unit root. This indicated that it did not have a unit root and it had stationary (Appendix 12).

The ADF statistic value of level form for log of irrigated area was -2.59. In addition, the critical values at 1%, 5% and 10% levels were -3.96, -3.08 and -2.68. The statistic t_α value was greater than the critical values so that we did not reject the null hypothesis. The ADF test statistic value had a probability value of 0.12, providing evidence that we might not reject the null hypothesis of a unit root. This indicated that it had a unit root (Appendix 13). The ADF statistic value of first difference level for log of irrigated area was -3.72. In addition, the critical values at 1%, 5% and 10% levels were -4.00, -3.10 and -2.69. The statistic t_α value was smaller than the critical values so that we must reject the null hypothesis. The ADF test statistic value has a probability value of 0.01, providing evidence that we might reject the null hypothesis of a unit root. This indicated that it did not have a unit root and it had stationary (Appendix 14).

The ADF statistic value of level form for log of HYV area was -2.17. In addition, the critical values at 1%, 5% and 10% levels were -3.83, -3.03 and -2.66. The statistic t_α value was greater than the critical values so that we did not reject the null hypothesis. The ADF test statistic value had a probability value of 0.22, providing evidence that we might not reject the null hypothesis of a unit root. This indicated that it had a unit root (Appendix 15). The ADF statistic value of first difference level for log of HYV was -3.50. In addition, the critical values at 1%, 5% and 10% levels were -3.86, -3.04 and -2.66. The statistic t_α value was smaller than the critical values so that we must reject the null hypothesis. The ADF test statistic value had a probability value of 0.02, providing evidence that we might reject the null hypothesis of a unit root. This indicated that it did not have a unit root and it had stationary (Appendix 16).

The ADF statistic value of level form for log of urea price was -1.78. In addition, the critical values at 1%, 5% and 10% levels were -3.83, -3.03 and -2.66. The statistic t_α value was greater than the critical values so that we did not reject the null hypothesis. The ADF test statistic value had a probability value of 0.38, providing evidence that we might not reject the null hypothesis of a unit root. This indicated that it had a unit root (Appendix 17). The ADF statistic value of first difference level for log of urea price was -4.65. In addition, the critical values at 1%, 5% and 10% levels were -3.86, -3.04 and -2.66. The statistic t_α value was smaller than the critical values so that we must reject the null hypothesis. The ADF test statistic value had a probability value of 0.00, providing evidence that we might reject the null hypothesis of a unit root. This indicated that it did not have a unit root and it had stationary (Appendix 18) .

The ADF statistic value of level form for log of lagged sown area was -0.75. In addition, the critical values at 1%, 5% and 10% levels were –3.83, -3.03 and -2.66. The statistic t_α value was greater than the critical values so that we did not reject the null hypothesis. The ADF test statistic value had a probability value of 0.81, providing evidence that we may not reject the null hypothesis of a unit root. This indicated that it had a unit root (Appendix 19). The ADF statistic value of first difference level for log of lagged sown area was -3.65. In addition, the critical values at the 1%, 5% and 10% levels were -3.86, -3.04 and -2.66. The statistic t_α value was smaller than the critical values so that we must reject the null hypothesis. The ADF test statistic value had a probability value of 0.01, providing evidence that we may reject the null hypothesis of a unit root. This indicated that it did not have a unit root and it had stationary (Appendix 20).

The ADF statistic value of level form for Log of annual rainfall was -4.08. In addition, the critical values at 1%, 5% and 10% levels were -3.83, -3.03 and -2.66. The statistic t_α value was smaller than the critical values so that we must reject the null hypothesis. The ADF test statistic value had a probability value of 0.00, providing evidence that we may not reject the null hypothesis of a unit root. This indicated that it had a unit root (Appendix 21). The ADF statistic value of first difference level for log of annual rainfall was -7.56. In addition, the critical values at 1%, 5% and 10% levels were -3.86, -3.04 and -2.66.

The statistic t_{α} value was smaller than the critical values so that we must reject the null hypothesis. The ADF test statistic value had a probability value of 0.00, providing evidence that we may reject the null hypothesis of a unit root. This indicated that it did not have a unit root and it had stationary (Appendix 22).

The ADF statistic value of level form for log of total production was 1.78. In addition, the critical values at 1%, 5% and 10% levels were -3.96, -3.03 and -2.68. The statistic t_{α} value was smaller than the critical values so that we did not reject the null hypothesis. The ADF test statistic value had a probability value of 0.99, providing evidence that we may not reject the null hypothesis of a unit root. This indicated that it had a unit root. The ADF statistic value of first difference level for log of total production was -3.44. In addition, the critical values at 1%, 5% and 10% levels were -3.86, -3.04 and -2.66. The statistic t_{α} value was smaller than the critical values so that we must reject the null hypothesis. The ADF test statistic value had a probability value of 0.02, providing evidence that we might reject the null hypothesis of a unit root. This indicated that it did not have a unit root and it had stationary.

6.3.2 Cointegration test

From Table 6.2, all variables became stationary at 5 percent level of significance. Given the above results, the co-integration relation among variables was checked using the cointegration technique proposed by Johansen and Juselius (1990) to identify long-term equilibrium relation(s) among the variables. The economic interpretation of co-integration was that if two (or more) series were linked to form an equilibrium relationship spanning the long-run, then even though the series themselves may contain stochastic trends (i.e, be non-stationary) they will nevertheless move closely together over time and the difference between them will be stable (i.e., stationary). Thus the concept of co-integration mimics the existence of a long-run equilibrium to which an economic system converges over time. Thus, following directly from the identification of co-integration with equilibrium, it is possible to make sense of regressions involving non-stationary variables. If these are co-integrated then regressions analysis imparts meaningful information about long-run relationships.

The result of the cointegration condition (that is the existence of a long term linear relation) was presented in Table 6.3 (Trace Statistics) and Table 6.4 (Maximum Eigenvalue) for area response and in Table 6.5(TraceSt atistics) and Table 6.6 (Maximum Eigenvalue) for yield response. The values of computed (λ trace) and (λ max) statistics were found to be less than the critical values as shown in Table 6.3, 6.4, 6.5 and 6.6. Therefore, both the (λ trace) and (λ max) statistics supports the hypothesis of no cointegration among the variables. In the cointegration tables, both trace statistic and maximum eigenvalue statistic indicated no cointegration at the 5 percent level of significance, suggesting that there is no cointegrating (or long run) relationship. Since the null hypothesis was accepted, there is no need to further subject the variables to error correction test.

6.3.3 Econometric Results

6.3.3.1 Regression analysis of area response function for rice

After finding that there was no co-integration, the model was estimated by ordinary least square method. The regression results using the variables such as paddy production, sown area, paddy price, irrigated area, HYV area, urea price and annual rainfall were illustrated in Table 6.7. The estimated coefficients were taken as elasticities since all variables have been used in logarithmic form. The dependent variable was total sown area. The independent variables were lagged paddy price, irrigated area, HYV area, urea price, lagged sown area and annual rainfall. To know area response function, lagged paddy price was included in the model because paddy price changes are relevant for producer decision-making. When the farmers sell their products, price of rice should be increased in order to cover the cost of production. If it is not, producers will have a tendency to reduce the sown area to rice.

In regression reults of area response function, F value showed that the model was significant at 1% level. R^2 value was 0.974 meaning that it can be explained on the variation in rice sown area by 97.4% in Table 6.7. The results indicated that the estimated coefficient of irrigated area was significant at 1 percent level meaning that if irrigated area goes up by 1 percent, on average, the sown area goes up by about 0.35 percent. Thus, the total sown area moved slowly in responsive to change in irrigated area.

Table 6.3 Unrestricted cointegration rank test (trace) for area response

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value(0.05)	Prob.**
None	0.879308	93.76427	95.75366	0.0680
At most 1	0.713183	53.58851	69.81889	0.4794
At most 2	0.546748	29.85923	47.85613	0.7261
At most 3	0.427461	14.82438	29.79707	0.7913
At most 4	0.199493	4.228550	15.49471	0.8842
At most 5	4.48E-05	0.000851	3.841466	0.9777

Trace test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 6.4 Unrestricted cointegration rank test (maximum eigenvalue) for area respones

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	Critical Value (0.05)	Prob.**
None *	0.879308	40.17575	40.27757	0.0487
At most 1	0.713183	23.72928	33.87687	0.4755
At most 2	0.546748	15.03485	27.58434	0.7455
At most 3	0.427461	10.59583	21.13162	0.6874
At most 4	0.199493	4.227699	14.26460	0.8346
At most 5	4.48E-05	0.000851	3.841466	0.9777

Max-eigenvalue test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 6.5 Unrestricted cointegration rank test (Trace) for yield response

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value (0.05)	Prob.**
None	0.900497	110.5219	125.6154	0.2856
At most 1	0.753217	66.67819	95.75366	0.8229
At most 2	0.613930	40.09255	69.81889	0.9462
At most 3	0.424570	22.00954	47.85613	0.9746
At most 4	0.288027	11.50943	29.79707	0.9476
At most 5	0.210589	5.054833	15.49471	0.8030
At most 6	0.029143	0.561947	3.841466	0.4535

Trace test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 6.6 Unrestricted cointegration rank test (maximum eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	Critical Value (0.05)	Prob.**
None	0.900497	43.84369	46.23142	0.0883
At most 1	0.753217	26.58564	40.07757	0.6621
At most 2	0.613930	18.08301	33.87687	0.8734
At most 3	0.424570	10.50010	27.58434	0.9766
At most 4	0.288027	6.454601	21.13162	0.9721
At most 5	0.210589	4.492885	14.26460	0.8040
At most 6	0.029143	0.561947	3.841466	0.4535

Max-eigenvalue test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

The regression results indicated that paddy sown area was much dependent on the use of high yielding varieties and lagged sown area. The estimated coefficient of HYV area was significant at 1 percent level and negative sign. The explanation is that after 2003, area on HYV is declining given the fact that traditional variety like Shwebo Paw San is substituting in place of HYV due to the quality and price of this variety of rice and access to market.

The elasticity of lagged sown area was 0.52 and it was strongly significant at 1 percent level. This meant that the expansion of rice area much depended on the area sown by previous year which is relevant with government's program for the agricultural development. In the regression, the coefficient of annual rainfall was 0.05 and it was not significant for area response function.

6.3.3.2 Regression analysis of yield response function for rice

In the yield response function, lagged paddy price, irrigation area, HYV area, urea price, sown area and annual rainfall in logarithm form were the independent variables, and total production was the dependent variable. In regression reults of yield response function, F value showed that the model was significant at 1% level. The adjusted R squared pointed out the model was significant and it could be explained on the variation in paddy production by 98.7 percent. The results of yield response function were described in Table 6.8.

According to the regression estimates, the significant influencing factors were sown area and annual rainfall. Paddy production had positive relationship with sown area and annual rainfall and it was significant at 1% and 5% level. If one percent increased in total sown area and annual rainfall, yield of paddy will be increased by 1.73 % and 0.16% respectively. Increases in agricultural production can be achieved either by an expansion of the sown area or by a rise in crop yields per unit area of land. The study was consistent with the study of L. Ernest Molua, 2010 in which rainfall was positive correlation with yield, attesting to the importance of rainfall in agriculture.

Table 6.7 Determinants of area response function for rice supply

Independent Variables	Coefficient	Std Deviation	t-Statistics	Probability
Constant	2.58**	1.38	1.87	0.08
Lagged paddy price	0.03^{ns}	0.02	1.29	0.22
Irrigated area	0.35***	0.11	3.23	0.00
HYV area	-0.16***	0.06	3.23	0.02
Urea price	-0.03 ^{ns}	0.02	-1.61	0.13
Lagged sown area	0.52***	0.16	3.25	0.00
Annual rainfall	0.05 ^{ns}	0.09	0.57	0.58
R-squared	0.973819			
Adjusted R-squared	0.961735			
No. of observation	21			
F-statistic	80.58916			
Probability (F- statistics)	0.000000			
Durbin-Watson stat	2.084064			

Note: Dependent Variable: Sown area (’000 ha)

***,** and * are significant level at 1%, 5% and 10% respectively, ns = not significant

Table 6.8 Determinants of yield response function for rice supply

Independent Variables	Coefficient	Std Deviation	t-Statistics	Probability
Constant	-5.74**	1.52	-3.78	0.00
Lagged paddy price	0.03 ns	0.02	1.47	0.17
Irrigated area	-0.13 ns	0.14	-0.90	0.38
HYV area	0.00 ns	0.07	0.03	0.97
Urea price	-0.00 ns	0.02	-0.00	0.99
Sown area	1.73***	0.19	8.90	0.00
Annual rainfall	0.16*	0.09	1.80	0.09
R-squared	0.9913			
Adjusted R-squared	0.9873			
No. of observation	21			
F-statistic	247.9871			
Probability (F- statistics)	0.000000			
Durbin-Watson stat	1.538011			

Note: Dependent Variable: Total production (million metric ton)

***,** and * are significant level at 1%, 5% and 10% respectively, ns = not significant

CHAPTER 7

Conclusions and Policy Implications

7.1 Summary Conclusions

The study aims to determine structure of exports for major agricultural commodities and its implications for the economic development in Myanmar. The study contributes to the understanding of agricultural export performance by focusing on the relative importance of factors influencing agricultural export performance, external demand and internal supply conditions. Based on the findings of the study, conclusion and recommendation can be drawn to point out the important facts especially for external demand conditions and internal supply factors for Myanmar rice export in the study period.

7.1.1 Role of world demand, competitiveness and diversification for major agricultural export commodities

In this study, econometric analysis examined the impact of world demand, competitiveness and export diversification on the export value of major agricultural exports commodities and the estimation was done with OLS covering the 21 years. World demand and competitiveness were statistically significant and the signs were positive. The results point out world demand and competitiveness play the important role.

By improving upon its market share in its traditional exports, Myanmar can increase its exports of major agricultural commodities under given world market conditions. To achieve sustainable agricultural growth, farmers of Myanmar face more difficult than those of other developing countries due to competitiveness of the producers which include the gradual removal of trade barriers, rising demand for higher quality and standard of agricultural commodities.

International demand for Myanmar's agricultural commodities is necessary to generate the nation's income in turn to develop the welfare of the farmers. As per importance of competitiveness, it is necessary to boost substantially even though competitiveness of agricultural commodities of Myanmar is weak due to lack of advance technology in agricultural production.

To raise agricultural productivity and to generate agricultural income, farmers need to keep pace with increasing domestic demand for food and to meet requirements for enhancing competitiveness and diversification. To be competitive its products in the world market, the government should invest not only in the irrigation and rural infrastructure but also agricultural research and supply chain management. According to external demand factors and products' competitiveness in the world markets, the farmers could be given price incentives to improve the quality and standard of agricultural products.

7.1.2 Gravity model results for export demand of rice

The main purpose of this part of the study is to find out the factors influencing the level of rice export between Myanmar and trading partners (Bangladesh and Indonesia). In this study, a gravity model has been estimated with OLS estimation covering the period of twenty-one years from 1990 to 2010. In Bangladesh, the three factors found to be most significant in all the gravity models are GDP, GDP per capita and price of competing country (India). GDP, GDP per capita, production and price of competing country (India) were statistically significant in all the gravity models of Indonesia. Population, purchasing power parity, price of competing country (Vietnam) and world rice price had no effect on export demand of rice between Myanmar and trading partners.

The results from the gravity model pointed out that export volume of Myanmar rice rely on the economic indicator of trading partners. The import share of Myanmar rice in Bangladesh steadily increased year after year but exception was found in 2006-2007. According to the research findings, the export price of Myanmar's rice was low due to poor quality in comparison with other exporters in the region. Myanmar will have comparative advantage if the export price of rice in competing countries rose. However, it needs to consider the substainable market for Myanmar rice for which the quality of rice should be improved. In order to get high quality of rice, rice breeding program or selection of good quality traditional rice varieties or introduction of improved or hybrid varieties have to be done. The government needs to emphasize on favourable policies and measures to improve the productivity of rice and to boost the export demand, along with putting initiatives in place to remove non tariff barrier from exports of rice.

7.1.3 Internal supply analysis of rice

The main purpose of this supply analysis of rice is to estimate the influencing factors of rice supply. In this study, area response function and yield response function had been estimated with OLS covering the period of twenty-one years from 1990 to 2010. Lagged sown area, irrigated area and HYV area were statistically significant in the regression of area response function. Sown area and rainfall were statistically significant in the regression of yield response function.

Lagged sown area was strongly significant at 1 percent level showing that the expansion of rice area much depended on the area sown by previous year which is relevant with government's program for the agricultural development. The total sown area moved slowly in responsive to change in irrigated area. After 2003, area on HYV is decling given the fact that traditional variety like Shwebo Paw San is substituting in place of HYV due to the quality and price of this variety of rice and access to market.

According to the regression estimates of yield response function, the significant influencing factors were sown area and annual rainfall. Paddy production had positive relationship with sown area and annual rainfall. Variability of rainfall is also an important constraint to the growth of rice production suggesting the importance of government investment in irrigation systems to reduce the risk of water shortages facing by rice producers frequently. The technological progress of rice production depends on the supply of irrigation facilities and utilization of HYVs but it was stable due to low investment by the government of Myanmar. During the study period, area expansion of rice has been possible only by horizontal expansion rather than vertical expansion.

7.2 Recommendation and Policy Implications

The focus of this study was only on external demand conditions and internal supply factors for rice export of Myanmar within the time frame of 21 years. Therefore, information was limited to provide a complete picture of the impact on agricultural trade. The scope of the study was limited because the degree of freedom was less than 30. The research's finding was representative for 21 years and validity might be weak. Therefore, the study recommended to carry out the further study understaning more on external demand and internal supply of rice if the data can be collected for last 50 years or 60 years period. Future studies can look more broadly on major agricultural commodities in order to present a wider picture of the impact of agricultural trade and to explain the constraints for export of major agricultural commodities. The additional study needs to find out why is low in the export price of Myanmar's rice.

Derived from the conclusion of the findings, it may be taken into account the following recommendations and policy implication for the policy makers in expansion of agricultural exports program.

- The government needs to consider the substainable market for Myanmar rice for which the quality of rice should be improved. In order to get high quality of rice, rice breeding program or selection of good quality traditional rice varieties or introduction of improved or hybrid varieties have to be done. Also it is very importance to set up participatory farmers' quality rice production and need to be promoted the training program on quality rice production.

- Improvement of rice milling is essential for rice industry development and rice trading. It needs to establish modern rice mills to fulfill the needs of targeted countries for the demand of rice.

- The government should invest not only in public goods like irrigation facilities and rural infrastructure but also in human resource development of institutions relating to agricultural research and supply chain management.

- If rice policy goes on prosperity of rice, the government needs to answer itself (1) where and how to sell rice, (2) which kind of variety needs to be focussed and (3) is there any competitive advantage for rice. Based on these answers, Myanmar can produce to achieve the target of rice as per requirements of the international markets.

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APPENDICES

Appendix 1 ADF level test for log of export value

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.755411	0.3901
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG(XV))

Method: Least Squares

Date: 09/02/13 Time: 22:40

Sample (adjusted): 2 21

Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(XV(-1))	-0.220629	0.125685	-1.755411	0.0962
C	2.852613	1.579120	1.806457	0.0876
R-squared	0.146170	Mean dependent var		0.084724
Adjusted R-squared	0.098734	S.D. dependent var		0.405208
S.E. of regression	0.384685	Akaike info criterion		1.021854
Sum squared resid	2.663682	Schwarz criterion		1.121427
Log likelihood	-8.218540	F-statistic		3.081468
Durbin-Watson stat	1.745844	Prob(F-statistic)		0.096193

Appendix 2 ADF first difference test for log of export value

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-3.925907	0.0099
Test critical values:	1% level	-3.920350		
	5% level	-3.065585		
	10% level	-2.673459		

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG(XV),2)

Method: Least Squares

Date: 09/02/13 Time: 22:44

Sample (adjusted): 6 21

Included observations: 16 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(XV(-1)))	-2.267709	0.577627	-3.925907	0.0024
D(LOG(XV(-1)),2)	1.406185	0.463108	3.036405	0.0113
D(LOG(XV(-2)),2)	0.589483	0.336057	1.754116	0.1072
D(LOG(XV(-3)),2)	0.638124	0.236702	2.695888	0.0208
C	0.207581	0.107811	1.925427	0.0804

R-squared	0.712453	Mean dependent var	-0.040249
Adjusted R-squared	0.607890	S.D. dependent var	0.538547
S.E. of regression	0.337231	Akaike info criterion	0.914209
Sum squared resid	1.250972	Schwarz criterion	1.155643
Log likelihood	-2.313672	F-statistic	6.813648
Durbin-Watson stat	1.670242	Prob(F-statistic)	0.005185

Appendix 3 ADF level test for log of export diversification

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.261387	0.6234
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

*MacKinnon (1996) one-sided p-values.

Warning: Probabilities and critical values calculated for 20 observations and may not be accurate for a sample size of 18

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG(DV))

Method: Least Squares

Date: 09/02/13 Time: 22:46

Sample (adjusted): 4 21

Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(DV(-1))	-0.385598	0.305694	-1.261387	0.2278
D(LOG(DV(-1)))	0.241061	0.250387	0.962753	0.3520
D(LOG(DV(-2)))	-0.481925	0.256007	-1.882468	0.0807
C	1.695779	1.340401	1.265128	0.2265

R-squared	0.483221	Mean dependent var	0.005997
Adjusted R-squared	0.372483	S.D. dependent var	0.100984
S.E. of regression	0.079996	Akaike info criterion	-2.020554
Sum squared resid	0.089591	Schwarz criterion	-1.822694
Log likelihood	22.18499	F-statistic	4.363633
Durbin-Watson stat	1.933192	Prob(F-statistic)	0.022862

Appendix 4 ADF first difference test for log of export diversification

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.668401	0.0003
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG(DV),2)

Method: Least Squares

Date: 09/02/13 Time: 22:48

Sample (adjusted): 4 21

Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(DV(-1)))	-1.623915	0.286485	-5.668401	0.0000
D(LOG(DV(-1)),2)	0.681592	0.205131	3.322714	0.0046
C	0.005181	0.019226	0.269496	0.7912

R-squared	0.686025	Mean dependent var	0.005029
Adjusted R-squared	0.644162	S.D. dependent var	0.136721
S.E. of regression	0.081557	Akaike info criterion	-2.024022
Sum squared resid	0.099773	Schwarz criterion	-1.875627
Log likelihood	21.21620	F-statistic	16.38728
Durbin-Watson stat	2.148527	Prob(F-statistic)	0.000169

Appendix 5 ADF level test for log of world demand

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.784295	0.8019
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG(WD))

Method: Least Squares

Date: 09/02/13 Time: 22:49

Sample (adjusted): 2 21

Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(WD(-1))	-0.115706	0.147528	-0.784295	0.4431
C	1.100045	1.366200	0.805186	0.4312

R-squared	0.033044	Mean dependent var	0.028959
Adjusted R-squared	-0.020676	S.D. dependent var	0.169101
S.E. of regression	0.170840	Akaike info criterion	-0.601535
Sum squared resid	0.525355	Schwarz criterion	-0.501962
Log likelihood	8.015355	F-statistic	0.615119
Durbin-Watson stat	1.420181	Prob(F-statistic)	0.443067

Appendix 6 ADF first difference test for log of world demand

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.064214	0.0066
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG(WD),2)

Method: Least Squares

Date: 09/02/13 Time: 22:49

Sample (adjusted): 4 21

Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(WD(-1)))	-1.167197	0.287189	-4.064214	0.0010
D(LOG(WD(-1)),2)	0.495389	0.234348	2.113903	0.0517
C	0.045281	0.039663	1.141659	0.2715

R-squared	0.530364	Mean dependent var	0.001796
Adjusted R-squared	0.467746	S.D. dependent var	0.221519
S.E. of regression	0.161611	Akaike info criterion	-0.656236
Sum squared resid	0.391772	Schwarz criterion	-0.507841
Log likelihood	8.906124	F-statistic	8.469822
Durbin-Watson stat	1.733559	Prob(F-statistic)	0.003453

Appendix 7 ADF level test for log of competitiveness

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.352545	0.5840
Test critical values:	1% level	-3.808546	
	5% level	-3.020686	
	10% level	-2.650413	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG(CM))

Method: Least Squares

Date: 09/02/13 Time: 22:50

Sample (adjusted): 2 21

Included observations: 20 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(CM(-1))	-0.171256	0.126618	-1.352545	0.1929
C	-0.401020	0.273551	-1.465978	0.1599

R-squared	0.092256	Mean dependent var	-0.033994
Adjusted R-squared	0.041826	S.D. dependent var	0.157896
S.E. of regression	0.154558	Akaike info criterion	-0.801852
Sum squared resid	0.429988	Schwarz criterion	-0.702279
Log likelihood	10.01852	F-statistic	1.829378
Durbin-Watson stat	1.958885	Prob(F-statistic)	0.192949

Appendix 8 ADF first difference test for log of competitiveness

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.247077	0.0045
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOG(CM),2)

Method: Least Squares

Date: 09/02/13 Time: 22:51

Sample (adjusted): 4 21

Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOG(CM(-1)))	-1.499763	0.353128	-4.247077	0.0007
D(LOG(CM(-1)),2)	0.375772	0.237797	1.580222	0.1349
C	-0.059523	0.040448	-1.471575	0.1618

R-squared	0.604028	Mean dependent var	0.008970
Adjusted R-squared	0.551232	S.D. dependent var	0.237589
S.E. of regression	0.159161	Akaike info criterion	-0.686786
Sum squared resid	0.379984	Schwarz criterion	-0.538391
Log likelihood	9.181076	F-statistic	11.44075
Durbin-Watson stat	2.079289	Prob(F-statistic)	0.000960

Appendix 9 ADF level test for log of sown area

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.727106	0.8166
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGSOWNAREA)

Method: Least Squares

Date: 06/15/13 Time: 10:29

Sample (adjusted): 2 20

Included observations: 19 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGSOWNAREA(-1)	-0.046716	0.064249	-0.727106	0.4771
C	0.434372	0.562119	0.772740	0.4503

R-squared	0.030161	Mean dependent var	0.025712
Adjusted R-squared	-0.026888	S.D. dependent var	0.041775
S.E. of regression	0.042333	Akaike info criterion	-3.387221
Sum squared resid	0.030465	Schwarz criterion	-3.287806
Log likelihood	34.17860	F-statistic	0.528684
Durbin-Watson stat	1.529351	Prob(F-statistic)	0.477055

Appendix 10: ADF first difference test for log of sown area

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.948827	0.0095
Test critical values:	1% level	-3.920350	
	5% level	-3.065585	
	10% level	-2.673459	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGSOWNAREA,2)

Method: Least Squares

Date: 06/15/13 Time: 10:29

Sample (adjusted): 5 20

Included observations: 16 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGSOWNAREA(-1))	-1.477023	0.374041	-3.948827	0.0019
D(LOGSOWNAREA(-1),2)	0.524069	0.283909	1.845907	0.0897
D(LOGSOWNAREA(-2),2)	0.471994	0.222369	2.122573	0.0553
C	0.036902	0.014344	2.572582	0.0244

R-squared	0.620170	Mean dependent var	-0.006477
Adjusted R-squared	0.525213	S.D. dependent var	0.051281
S.E. of regression	0.035335	Akaike info criterion	-3.635549
Sum squared resid	0.014983	Schwarz criterion	-3.442402
Log likelihood	33.08440	F-statistic	6.531035
Durbin-Watson stat	2.147016	Prob(F-statistic)	0.007228

Appendix 11 ADF level test for log of lagged paddy price

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.122774	0.9334
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGLAGGED_PADDY_PRICE)

Method: Least Squares

Date: 06/15/13 Time: 10:33

Sample (adjusted): 2 20

Included observations: 19 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGLAGGED_PADDY_PRICE(-1)	-0.006844	0.055746	-0.122774	0.9037
C	0.298772	0.545565	0.547637	0.5911
R-squared	0.000886	Mean dependent var		0.232488
Adjusted R-squared	-0.057886	S.D. dependent var		0.332744
S.E. of regression	0.342239	Akaike info criterion		0.792687
Sum squared resid	1.991170	Schwarz criterion		0.892101
Log likelihood	-5.530525	F-statistic		0.015073
Durbin-Watson stat	1.976326	Prob(F-statistic)		0.903726

Appendix 12 ADF first difference test for log of lagged paddy price

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.122322	0.0014
Test critical values:	1% level	-4.004425	
	5% level	-3.098896	
	10% level	-2.690439	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGLAGGED_PADDY_PRICE,2)

Method: Least Squares

Date: 06/15/13 Time: 10:34

Sample (adjusted): 7 20

Included observations: 14 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGLAGGED_PADDY_PRICE(-1))	-3.466961	0.676834	-5.122322	0.0009
D(LOGLAGGED_PADDY_PRICE(-1),2)	2.138618	0.556768	3.841131	0.0049
D(LOGLAGGED_PADDY_PRICE(-2),2)	1.614446	0.446800	3.613357	0.0068
D(LOGLAGGED_PADDY_PRICE(-3),2)	1.025490	0.321923	3.185516	0.0129
D(LOGLAGGED_PADDY_PRICE(-4),2)	0.693568	0.213049	3.255440	0.0116
C	0.911016	0.189388	4.810327	0.0013

R-squared	0.836874	Mean dependent var	0.013783
Adjusted R-squared	0.734921	S.D. dependent var	0.524876
S.E. of regression	0.270237	Akaike info criterion	0.518490
Sum squared resid	0.584223	Schwarz criterion	0.792372
Log likelihood	2.370571	F-statistic	8.208384
Durbin-Watson stat	2.196204	Prob(F-statistic)	0.005182

Appendix 13 ADF level test for log of irrigated area

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.591195	0.1162
Test critical values:	1% level	-3.959148	
	5% level	-3.081002	
	10% level	-2.681330	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGIRRIGATED_AREA)

Method: Least Squares

Date: 06/15/13 Time: 10:37

Sample (adjusted): 6 20

Included observations: 15 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGIRRIGATED_AREA(-1)	-0.303139	0.116988	-2.591195	0.0292
D(LOGIRRIGATED_AREA(-1))	-0.269832	0.241476	-1.117428	0.2928
D(LOGIRRIGATED_AREA(-2))	0.017047	0.143500	0.118798	0.9080
D(LOGIRRIGATED_AREA(-3))	-0.335251	0.141001	-2.377645	0.0414
D(LOGIRRIGATED_AREA(-4))	-0.318959	0.183233	-1.740726	0.1157
C	2.363018	0.892547	2.647501	0.0266

R-squared	0.647628	Mean dependent var	0.025363
Adjusted R-squared	0.451865	S.D. dependent var	0.060927
S.E. of regression	0.045108	Akaike info criterion	-3.070356
Sum squared resid	0.018312	Schwarz criterion	-2.787136
Log likelihood	29.02767	F-statistic	3.308233
Durbin-Watson stat	1.790481	Prob(F-statistic)	0.056976

Appendix14 ADF first difference test for log of irrigated area

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.717540	0.0167
Test critical values:	1% level	-4.004425	
	5% level	-3.098896	
	10% level	-2.690439	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGIRRIGATED_AREA,2)

Method: Least Squares

Date: 06/15/13 Time: 10:38

Sample (adjusted): 7 20

Included observations: 14 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGIRRIGATED_AREA(-1))	-1.567315	0.421600	-3.717540	0.0059
D(LOGIRRIGATED_AREA(-1),2)	0.254772	0.296327	0.859765	0.4149
D(LOGIRRIGATED_AREA(-2),2)	0.249070	0.171115	1.455570	0.1836
D(LOGIRRIGATED_AREA(-3),2)	-0.029787	0.168134	-0.177163	0.8638
D(LOGIRRIGATED_AREA(-4),2)	-0.235743	0.140078	-1.682933	0.1309
C	0.045704	0.019972	2.288333	0.0514

R-squared	0.894407	Mean dependent var	-0.005525
Adjusted R-squared	0.828412	S.D. dependent var	0.095169
S.E. of regression	0.039422	Akaike info criterion	-3.331451
Sum squared resid	0.012433	Schwarz criterion	-3.057570
Log likelihood	29.32016	F-statistic	13.55255
Durbin-Watson stat	2.540592	Prob(F-statistic)	0.000983

Appendix 15 ADF level test for log of HYV area

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.172896	0.2214
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGHYV_AREA)

Method: Least Squares

Date: 06/15/13 Time: 10:40

Sample (adjusted): 2 20

Included observations: 19 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGHYV_AREA(-1)	-0.255747	0.117699	-2.172896	0.0442
C	2.129033	0.967320	2.200961	0.0418

R-squared	0.217364	Mean dependent var	0.027827
Adjusted R-squared	0.171327	S.D. dependent var	0.117705
S.E. of regression	0.107148	Akaike info criterion	-1.529905
Sum squared resid	0.195173	Schwarz criterion	-1.430490
Log likelihood	16.53409	F-statistic	4.721477
Durbin-Watson stat	1.737144	Prob(F-statistic)	0.044216

Appendix 16 ADF first difference test for log of HYV area

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.501294	0.0205
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGHYV_AREA,2)

Method: Least Squares

Date: 06/15/13 Time: 10:40

Sample (adjusted): 3 20

Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGHYV_AREA(-1))	-0.867210	0.247683	-3.501294	0.0030
C	0.025546	0.029880	0.854976	0.4052

R-squared	0.433810	Mean dependent var	0.002299
Adjusted R-squared	0.398423	S.D. dependent var	0.159357
S.E. of regression	0.123599	Akaike info criterion	-1.239106
Sum squared resid	0.244428	Schwarz criterion	-1.140175
Log likelihood	13.15195	F-statistic	12.25906
Durbin-Watson stat	1.950135	Prob(F-statistic)	0.002955

Appendix 17 ADF level test for log of urea price

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.775068	0.3804
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGUREA_PRICE)

Method: Least Squares

Date: 06/15/13 Time: 10:47

Sample (adjusted): 2 20

Included observations: 19 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGUREA_PRICE(-1)	-0.115067	0.064824	-1.775068	0.0938
C	1.205814	0.552957	2.180665	0.0435

R-squared	0.156364	Mean dependent var	0.241245
Adjusted R-squared	0.106738	S.D. dependent var	0.472142
S.E. of regression	0.446233	Akaike info criterion	1.323350
Sum squared resid	3.385108	Schwarz criterion	1.422765
Log likelihood	-10.57183	F-statistic	3.150868
Durbin-Watson stat	2.391860	Prob(F-statistic)	0.093792

Appendix 18 ADF first difference test for log of urea price

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.652307	0.0020
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGUREA_PRICE,2)

Method: Least Squares

Date: 06/15/13 Time: 10:47

Sample (adjusted): 3 20

Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGUREA_PRICE(-1))	-1.156278	0.248539	-4.652307	0.0003
C	0.295168	0.132442	2.228657	0.0405

R-squared	0.574965	Mean dependent var	-0.004632
Adjusted R-squared	0.548400	S.D. dependent var	0.730501
S.E. of regression	0.490905	Akaike info criterion	1.519308
Sum squared resid	3.855808	Schwarz criterion	1.618238
Log likelihood	-11.67377	F-statistic	21.64396
Durbin-Watson stat	2.011269	Prob(F-statistic)	0.000266

Appendix 19 ADF level test for log of lagged sown area

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.746243	0.8114
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGLAGGED_SOWN_AREA)

Method: Least Squares

Date: 06/15/13 Time: 10:50

Sample (adjusted): 2 20

Included observations: 19 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGLAGGED_SOWN_AREA(-1)	-0.047360	0.063464	-0.746243	0.4657
C	0.441902	0.553411	0.798505	0.4356

R-squared	0.031719	Mean dependent var	0.028986
Adjusted R-squared	-0.025239	S.D. dependent var	0.041802
S.E. of regression	0.042326	Akaike info criterion	-3.387520
Sum squared resid	0.030456	Schwarz criterion	-3.288105
Log likelihood	34.18144	F-statistic	0.556879
Durbin-Watson stat	1.736358	Prob(F-statistic)	0.465716

Appendix 20 ADF first difference test for log of lagged sown area

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.646326	0.0153
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGLAGGED_SOWN_AREA,2)

Method: Least Squares

Date: 06/15/13 Time: 10:50

Sample (adjusted): 3 20

Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGLAGGED_SOWN_AREA(-1))	-0.906298	0.248551	-3.646326	0.0022
C	0.024467	0.012757	1.917933	0.0731

R-squared	0.453845	Mean dependent var	-0.003234
Adjusted R-squared	0.419710	S.D. dependent var	0.057077
S.E. of regression	0.043480	Akaike info criterion	-3.328612
Sum squared resid	0.030248	Schwarz criterion	-3.229681
Log likelihood	31.95750	F-statistic	13.29569
Durbin-Watson stat	1.731659	Prob(F-statistic)	0.002176

Appendix 21 ADF level test for log of annual rainfall

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.077138	0.0060
Test critical values:	1% level	-3.831511	
	5% level	-3.029970	
	10% level	-2.655194	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGANNUAL_RAINFALL)

Method: Least Squares

Date: 06/15/13 Time: 10:53

Sample (adjusted): 2 20

Included observations: 19 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGANNUAL_RAINFALL(-1)	-1.002654	0.245921	-4.077138	0.0008
C	7.751295	1.902393	4.074498	0.0008

R-squared	0.494394	Mean dependent var	-0.004465
Adjusted R-squared	0.464653	S.D. dependent var	0.135892
S.E. of regression	0.099429	Akaike info criterion	-1.679448
Sum squared resid	0.168064	Schwarz criterion	-1.580034
Log likelihood	17.95476	F-statistic	16.62305
Durbin-Watson stat	1.906664	Prob(F-statistic)	0.000785

Appendix 22 ADF first difference test for log of annual rainfall

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.565013	0.0000
Test critical values:	1% level	-3.857386	
	5% level	-3.040391	
	10% level	-2.660551	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(LOGANNUAL_RAINFALL,2)

Method: Least Squares

Date: 06/15/13 Time: 10:54

Sample (adjusted): 3 20

Included observations: 18 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGANNUAL_RAINFALL(-1))	-1.555895	0.205670	-7.565013	0.0000
C	0.001137	0.027678	0.041078	0.9677

R-squared	0.781509	Mean dependent var	0.001351
Adjusted R-squared	0.767853	S.D. dependent var	0.243722
S.E. of regression	0.117429	Akaike info criterion	-1.341518
Sum squared resid	0.220635	Schwarz criterion	-1.242588
Log likelihood	14.07366	F-statistic	57.22943
Durbin-Watson stat	2.125037	Prob(F-statistic)	0.000001