**UNIVERSITI PUTRA MALAYSIA**

# *PROFITABILITY AND TECHNICAL EFFICIENCY OF AUTO RICE MILLS IN BANGLADESH*

**MD. MAHBUBUR RAHMAN**

**IKDPM 2013 4**

PROFITABILITY AND TECHNICAL EFFICIENCY OF AUTO RICE MILLS IN BANGLADESH

By

MD. MAHBUBUR RAHMAN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in fulfillment of the Requirement for the Degree of Master of Science

February, 2013

***In the Name of Allah, Most Gracious, Most Merciful***

## *Dedication*

*To my beloved motherland Bangladesh, a place of love and peace*

*To my loving parents: they know why*

*To my wife Selina Tasnin Khan*

*&*

*To my beautiful daughter Moontaha Tarannum Esaba*

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

# ROFITABILITY AND TECHNICAL EFFICIENCY OF AUTO RICE MILLS IN BANGLADESH

By

**MD. MAHBUBUR RAHMAN**

**February, 2013**

**Chairman: Amin Mahir Bin Abdullah, PhD**

**Institute: Institute of Agricultural & Food Policy Studies**

This study is concerned with the profitability and technical efficiency of the selected Auto Rice Mills (ARMs) in Bangladesh. It has made use of data collected from 35 ARMs from the districts of Naogaon, Dinajpur, Mymensingh, Sherpur and Kustia. A structured questionnaire was used to collect the information. The specific objectives of the study are: i. to estimate cost, return and profitability of the ARMs, ii. to determine overall technical efficiency, pure technical efficiency and scale efficiency of the ARMs and iii. to identify factors affecting operation of ARMs. Farm management method has been applied to determine gross margin, net margin, break-even price and break-even production, while Data Envelopment Analysis (DEA) method is used to determine the technical and scale efficiency of the ARMs.

An average rice mill was required to spend US$ 5.31 million per year for its paddy processing operations. The variable cost constituted 98.65% while the fixed cost formed only 1.35% of the total cost. Two most important components of the total

costs are for paddy and energy, which constitutes about 92.00% and 4.00% respectively. The total revenue of the rice mills comprises 86.14% of polished rice, 4.31% of bran, 4.78% of broken rice, 1.60% of black/dead rice and 2.90% worth of husk. Gross margin and net margin per year ARM are US$ 1.00 million and US$ 0.93 million respectively. As net margins are positive, the ARMs appear to be sustainable not only in the short-run but also in the long-run. The gross and net margins per metric tonne of polished rice are US$ 79.65 and US$ 73.99 respectively. The break-even price per metric tonne of polished rice was found to be US$ 418 while the average break-even production of polished rice was 12,436 metric tonne suggesting also that the mills were running at profit.

The overall technical efficiency score of the rice mills is found to be 0.898 comprising 95.80% of pure technical efficiency and 93.70% of scale efficiency. Pure Technical Efficiency score suggeests that ARMs operate at about 4% below their frontier production, which means thatt 4% more polished rice could be produced with the existing levels of inputs use if all mills are operating at full efficiency level. About 46% ARMs achieved 100% pure technical efficiency score. The mean scale efficiency was 0.937. Percent of ARMs operated at decreasing returns to scales, constant returns to scales and increasing returns to scales are 6, 71 and 23% respectively. The overall average excess inputs usage levels are 24.26% for investment, 10.02% for paddy, 10.23% for labour, 12.06% for energy and 21.65% for default capacity. Problems faced by the auto rice millers are disrupted electricity supply, anti-holding act, existence of too many rice mills, high transport cost, seasonality of paddy supply, non-availability of skilled person to deal with breakdown, failure and maintenance , and finally scarcity of running capital.

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

**KEUNTUNGAN DAN KEBERKESANAN TEKNIKAL KILANG PEMPROSESAN PADI SECARA AUTOMATIK DI BANGLADESH**

Oleh

**MD. MAHBUBUR RAHMAN**

**Februari, 2013**

**Pengerusi: Amin Mahir Bin Abdullah, PhD**

**Institut: Pengajian Agrikultur dan Polisi Pengajian Makanan.**

Kajian ini adalah berkenaan dengan ekonomi dan kecekapan teknikal dalam pemprosesan padi oleh kilang beras auto terpilih di Bangladesh. Kajian ini telah dibuat menggunakan data yang dikumpul daripada 35 jenis kilang beras auto dari daerah Naogoan, Dinajpur, Mymensingh, Sherpur dan Kustia. Soal selidik berstruktur telah digunakan untuk mengumpul maklumat. Objektif khusus kajian ini adalah: i. untuk menganggarkan kos, pulangan dan keuntungan Pengilangan Beras Automatik, ii. untuk menentukan keseluruhan kecekapan teknikal Pengilangan Beras Auto dan iii. Kaedah pengurusan ladang telah digunakan untuk menentukan margin kasar, margin bersih, nisbah faedah-kos, harga dan pengeluaran pulang modal, manakala analisis data keseluruhan digunakan untuk menentukan kecekapan teknikal sistem kilang pemprosesan beras auto.

Secara purata sebuah kilang beras sederhana memerlukan sejumlah US$ 5.31 million setahun bagi operasi pemprosesan padi. Kos berubah-ubah adalah 98.65% manakala

kos tetap adalah hanya 1.35% daripada jumlah keseluruhan kos. Daripada jumlah kos, dua komponen yang paling penting adalah kos padi dan tenaga yang masing-masing menyumbang kira-kira 92% dan 4%. Jumlah hasil kilang beras terdiri daripada 86.14% daripada beras yang diproses, 4.31% dedak, 4.78% beras hancur, 1.60% beras hitam / mati dan 2.90% merupakan sekam. Margin kasar dan margin bersih setiap tahun masing-masing bernilai US$ 1.00 dan US$ 0.93 million setiap tahun. Sejak margin bersih adalah positif, kilang mampan bukan sahaja dalam jangka masa pendek tetapi juga dalam jangka masa panjang. Margin kasar dan bersih setiap tan beras diproses telah dianggarkan pada US$ 79.65 dan 73.99. Harga setiap tan beras diproses didapati adalah US$ 418 manakala purata beras dibersihkan walaupun pengeluaran beras diproses ialah 12,436 tan metrik setahun juga mencadangkan bahawa kilang telah mendapat keuntungan.

Kecekapan keseluruhan kilang beras adalah 0.898 yang terdiri daripada 95.80% kecekapan teknikal tulen dan 93.70% adalah kecekapan skala. Kilang-kilang beras auto beroperasi pada tahap kira-kira 4% lebih rendah daripada pengeluaran utama. Kira-kira 4% atau lebih beras yang telah diproses bersih boleh dihasilkan dengan mengekalkan input yang sedia ada jika semua kilang beroperasi dengan penuh efisien. Kira-kira 46% kilang pemprosesan beras auto telah mencapai 100% skor ketulenan teknologi efisyen. Kecekapan skala purata adalah 0.937. Peratusan kilang pemprosesan beras auto menurun kepada skala mendatar kepada skal, dan meningkat kepada skala iaitu 6, 71 dan 23%. Penggunaan berlebihan input purata keseluruhan adalah 24.26% untuk pelaburan, 10.02% bagi padi, 10.23% bagi buruh, 12.06% untuk tenaga dan 21.65% bagi kapasiti lalai. Masalah yang dihadapi oleh kilang pemprosesan auto ialah gangguan bekalan elektrik, akta anti-holding, kewujudan kilang beras yang terlalu banyak, kos pengangkutan yang tinggi, bekalan padi bermusim, kekurangan tenaga mahir untuk berhadapan dengan kerosakan dan penyelengaraan serta kekurangan modal semasa.

## ACKNOWLEDGEMENTS

First and foremost, I would like to extend my gratitude to almighty Allah for His mercy and grace because of which I was able to complete my study in spite of many challenges that I had to go through.

I would also like to express my sincere gratitude and appreciation to Dr. Amin Mahir bin Abdullah, chairman of my supervisory committee, whose guidance, invaluable suggestions, advices, endless support, and constant feedback helped me writing my dissertation from the very beginning until the final stage of this research.

With a great deal of luck, I got an excellent supervisory committee. I am thankful to Professor Dr. Mohd Mansor bin Ismail, Institute of Agricultural and Food Policy Studies, UPM for his constant help and guidance.

I cannot find words to express my deep sense of respect to Prof. Dr. Md. Ferdous Alam. However I would like to take this opportunity to express my sincere gratitude to Prof. Md. Ferdous Alam, fellow Researcher, Institute of Agricultural and Food Policy Studies, UPM for making many helpful guidance and suggestions throughout the study.

I sincerely acknowledge the Ministry of Food and Disaster Management, Government of the People's Republic of Bangladesh authority for nominating me and providing deputation and other supports to commence my study overseas. It gives me much pleasure to express heartfelt gratitude and sincere appreciation to all my colleagues especially my honorable Director General Mr. Naser Farid of the Food Planning and Monitoring Unit (FPMU) and directorate of food.

I would like to thank Food and Agriculture Organization of the United Nations (FAO) for providing the fellowship award. I am deeply grateful to Dr. Ciro Fiorillo, Chief Technical Adviser (CTA), of the National Food Policy Capacity Strengthening Programme (NFPCSP), Prof. Dr. Rezaul Karim Talukder, Prof. Dr. S.A.Sabur and Dr. Nur A. Khondaker for their support and an encouragement to join the degree.

I am thankful to my dear friends Farjana Rafiq,Al-amin Sarker, Safwana Haque, Md. Masudul Hasan Rezwan Iqbal and Rakib for their everlasting love, affection, continuous support, and encouragement that have been fundamental in my successful performance at every stage.

I acknowledge my heartfelt gratitude to all the teachers, staffs of Institute of Agricultural and Food Policy Studies, UPM for their help, encouragement, guidance and good advice.

This list is far from exhaustive; my humble apology to those who helped me a lot but not find their names here.

Md. Mahbubur Rahman
UPM, Malaysia
February, 2013

I certify that a Thesis Examination Committee has met on 25 February 2013 to conduct the final examination of Md. Mahbubur Rahman on his thesis entitled "Profitability and Technical Efficiency of Auto Rice Mills in Bangladesh" in accordance with the Universiti and Universiti College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

**Shaufique Fahmi bin Ahmad Sidique, Phd**
Senior Lecturer
Faculty of Economics and Management
Universiti Putra Malaysia
(Chairman)

**Mad Nasir bin Hj Shamsudin, Phd**
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

**Ismail bin Abd Latif, Phd**
Senior Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

**Dato' Dr. Jamalludin bin Sulaiman, Phd**
Professor
School Of Social Sciences
Universiti Sains Malaysia
Malaysia
(External Examiner)

**Seow Heng Fong, Phd**
Professor and Deputy Dean
School Of Graduate Studies
Universiti Putra Malaysia

Date: 30 April 2013

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

**Amin Mahir Abdullah, PhD**
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

**Mohd Mansor Bin Ismail, PhD**
Professor
Institute of Agricultural and Food Policy Studies,
Universiti Putra Malaysia
(Member)

**Md. Ferdous Alam, PhD**
Fellow Researcher
Institute of Agricultural and Food Policy Studies
Universiti Putra Malaysia
(Member)

**BUJANG BIN KIM HUAT, PhD**
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 30 April, 2013

**DECLARATION**

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

**MD. MAHBUBUR RAHMAN**

Date : February, 2013

# TABLE OF CONTENTS

## LIST OF TABLES

**LIST OF FIGURES**

## LIST OF ABBREVIATION

| | |
|---|---|
| ARMs | Auto Rice Mills |
| BB | Bangladesh Bank |
| BBS | Bangladesh Bureau of Statistics |
| BCR | Benefit- Cost Ratio |
| Crs | Constant Returns to Scale |
| CU | Cost per unit |
| Decap | Default Capacity of Machine |
| DAE | Department of Agriculture Extension |
| DEA | Data Envelopment Analysis |
| Drs | Decreasing Return to Scale |
| DOM | Degree of Milling |
| DG Food | Director General of Food |
| DMUs | Decision making Units |
| FAO | Food & Agriculture Organization of United Nations |
| FC | Fixed cost |
| FY | Fiscal Year |
| GDP | Gross Domestic Product at market price |
| GR | Gratuitous Relief |
| GM | Gross Margin |
| HYV | High Yield Varity |
| IRRI | International Rice Research Institute |
| irs | Increase Return to Scale |
| IU | Income per unit |
| Kcal | Kilocalorie |

| | |
|---|---|
| Kg | Kilogram |
| Km | Kilometer |
| MoF | Ministry of Finance |
| MT | Metric Tonne |
| MMT | Million Metric Tonne |
| PFDS | Public Food Distribution System |
| PDB | Power Development Board |
| RTS | Returns to Scale |
| R&M | Repair & maintenance |
| SE | Scale of Efficiency |
| TC | Total Cost |
| TE | Technical Efficiency |
| TEcrs | Technical Efficiency constant returns to scale |
| TEvrs | Technical Efficiency variable return to scale |
| TFC | Total Fixed Cost |
| TK | Taka |
| TR | Total Revenue |
| TVC | Total Variable Cost |
| UNDP | United Nation Development Programme |
| VAT | Value Added Tax |
| VGD | Vulnerable Group Development |
| VGF | Vulnerable Group Feeding |
| VRS | Variables Returns to Scale |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background of the Bangladesh economy

The People's Republic of Bangladesh is a sovereign state situated in South Asia. Bangladesh emerged as an independent country in 1971 following a nine month war of liberation. The country is bordered on the west, north, and east by India, on the southeast by Myanmar, and on the south by the Bay of Bengal. The capital (and largest city) is Dhaka, located in central Bangladesh. With a total area of 147,570 square kilometer, most of Bangladesh lies within the broad delta formed by the Ganges and Brahmaputra rivers (BBS, Bangladesh Bureau of Statistics, 2011). The country is an exceedingly flat, low-lying, alluvial plain traversed by more than 230 rivers and rivulets (with a total length of 24,140 km) and has a coastline of about 580 km along the Bay of Bengal. The literacy rate of Bangladeshi people is 43.1%.The majority (about 88%) of the people are Muslim. Bangladesh is characterized by a high population about 152 million (2011 year estimate), rapid population growth 1.37 per year, high population density, about 1015 person per $km^2$ and low per capita income US$ 818 per annum, (MoF, Ministry of Finance, 2011). Total area is 14.845 million hectare in which forest area occupies 2.599 million hectare. Total cultivable land is 8.44 million hectares. Cropping intensity is 1.76. Total cropped area is 13.742 million hectare including double and triple cropped area. Agriculture stands as one of the dominant sectors of the economy of Bangladesh. The contribution of this sector to GDP (gross domestic product) stood at 20.49% in FY (Fiscal Year) 2008-09. About 43.6% of the total labour force of the country is engaged in agricultural sector (BBS, 2009).

Export earnings from agricultural products in the FY 2009-10 constituted 4.24% of total export earnings. Raw jute, jute goods, tea, frozen foods are some exportable items. However, readymade garments provide the largest share to the total export earning comprising 80% of the entire export earnings while home textiles and other non-apparel textile products earned around 6% (BBS, 2011). Remittance from more than 6 million expatriate Bangladeshis in 2009-10 fiscal year totaled 10.97 billion U.S. dollars (MoF, 2011).

## 1.2 Rice in Bangladesh

Rice is the staple food of about 152 million people of Bangladesh. It occupies more than 77% of the total cultivated area. It is cultivated both in the tropical and sub tropical regions extending from 450 N to 400 S latitude. It provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country. Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Almost all of the 13 million farm families of the country grow rice. Rice is grown on about 10.5 million hectares of land which has remained almost stable over the past three decades. About 78% of the total cropped area and over 80% of the total irrigated area is planted to rice. Thus, rice plays a vital role in the livelihood of the people of Bangladesh.

Total rice production in Bangladesh was about 10.59 million metric tonnes in the year 1971 when the country's population was only about 70.88 millions. However, the country is now producing about 25.0 million metric tonnes to feed her 152.00

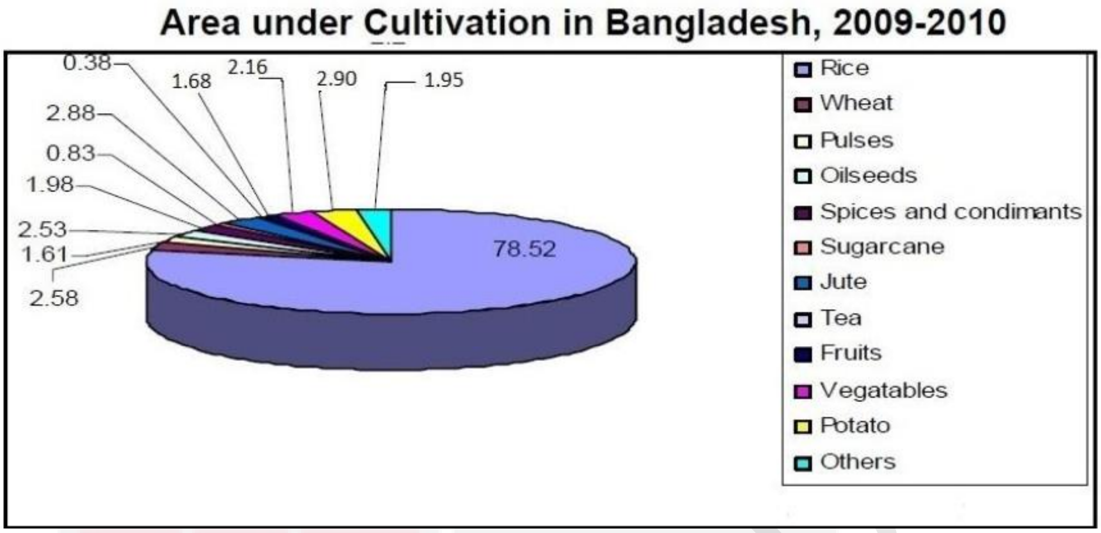


**Figure 1.1 Area under cultivation in Bangladesh, 2009-2010**
(Source: BBS, 2010)

million people. This indicates that the growth of rice production was much faster than the growth of population. This increased rice production has been possible largely due to the adoption of modern rice varieties on around 66% of the rice land which contributes to about 73% of the country's total rice production. The population of Bangladesh is growing by two million every year and may increase by another 30 million over the next 20 years.

### 1.2.1 Rice producing areas in Bangladesh

Rice is grown in almost all the districts of Bangladesh. However, the most concentrating zones for rice production are country's northwestern and northeastern regions. South eastern districts of Bangladesh produce relatively less rice. The most important rice producing districts are Rangpur, Rajshahi, Dinajpur, Sylhet, Jessore, Comilla, Bogra, Mymensingh, and Barisal (See Figure 1.2).

### 1.2.2 Cropping season and cropping pattern of rice

Rice is grown in a complex mosaic of single-, double-, and triple-crop patterns across Bangladesh in the *boro*, *aus,* and *aman* seasons. It has been broadly divided into three classes viz, *aman* (transplanted and broadcast varieties of rice), *boro*, and *aus* according to the season in which they are harvested, in December-January, March-May and July-August respectively. Sowing and harvesting period of different varieties of rice are shown in table 1.1. There are mainly three varieties of rice namely, *aus, aman* and *boro* grown in Bangladesh.

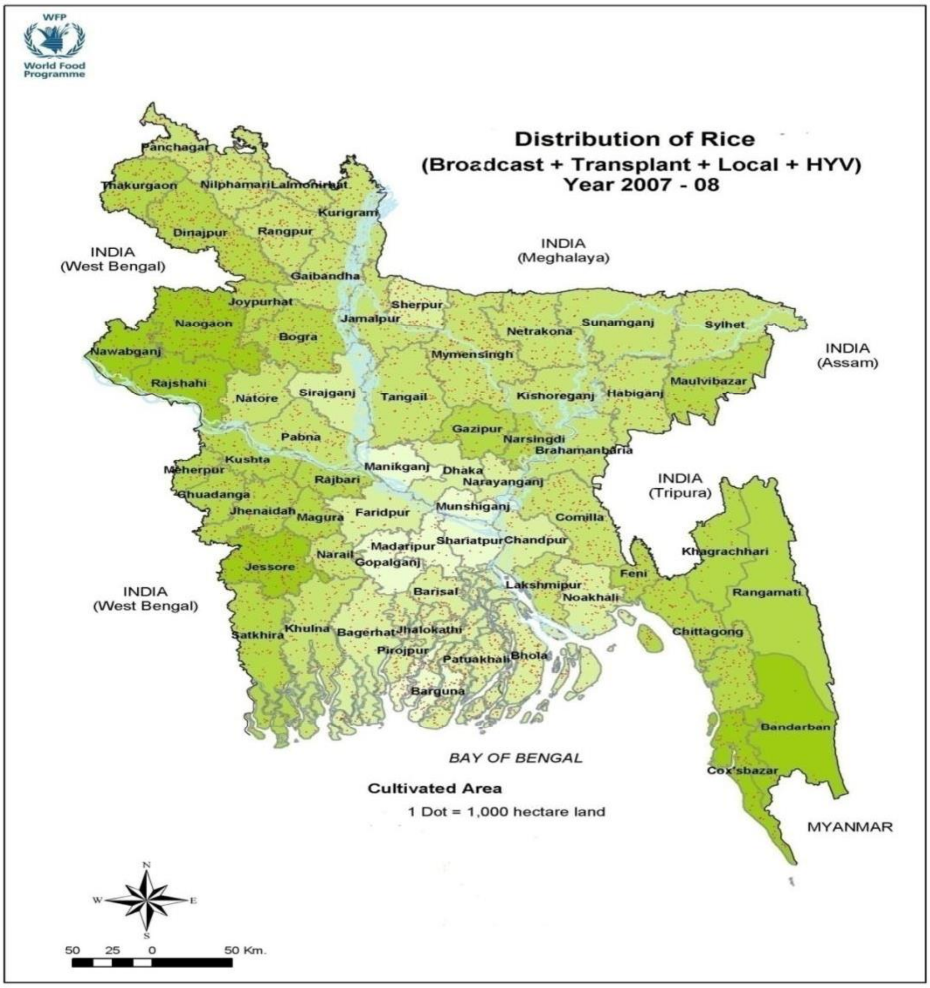


**Figure 1.2 Map of Bangladesh showing paddy producing districts**
Source: BBS, 2008

**Table 1.1 Rice calendar for Bangladesh**

| Rice | Sowing Period | Harvesting Period |
|---|---|---|
| *Aus* | Mid March to mid April | Mid July to Early Aug |
| *Aman*- Broadcast | Mid March to mid April | Mid November to mid December |
| *Aman* –Transplant | End of June to early September | December to early January |
| *Boro*-Local | Mid November to mid January | April to May |
| *Boro*-HYV | December to mid February | Mid April to June |

Source: BBS, 2011

Of these varieties transplanted *aman* is the most important covering about 49.87% of the total paddy area, followed by *boro* (41.46%), and *aus* (8.67%) (Figure 1.3) (BBS, 2010). Transplanted *aman* is grown almost everywhere in Bangladesh, while broadcast *aman* is mostly grown in the low-lying areas of the south and northeast. *Boro* is grown to a certain extent in every district, especially in the irrigated part, while *aus* are a well scattered crop (BBS, 2010).

The volume of food grains production in FY 2009-10 was 34.11 million metric tonnes of which *Boro* accounted for 18.34 million metric tonnes (53%), *Aman* 12.21 million metric tonnes (36%), *Aus* 1.71 million metric tonnes (5%), and wheat 0.97 million metric tonnes (4%) and maize 0.89 million metric tonnes (3%).

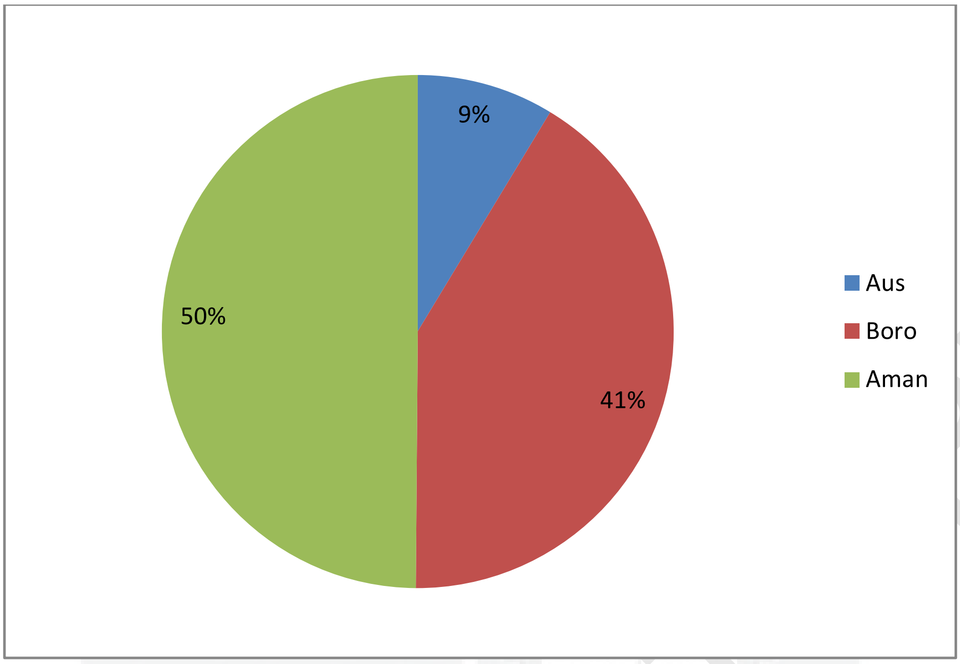


**Figure 1.3 Area under different varieties of rice cultivation in Bangladesh**

Source: BBS, 2010.

**Table 1.2 Rice productions in Bangladesh during 2003-04 to 2010-11**

(In million metric tonne)

| Food grain | 2003-04 | 2004-05 | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 (Estimate) |
|---|---|---|---|---|---|---|---|---|
| *Boro* | 12.84 | 13.84 | 13.98 | 14.97 | 17.76 | 17.81 | 18.34 | 18.65 |
| *Aman* | 11.52 | 9.82 | 10.81 | 10.84 | 9.66 | 11.61 | 12.21 | 13.20 |
| *Aus* | 1.832 | 1.50 | 1.75 | 1.51 | 1.51 | 1.90 | 1.71 | 2.50 |
| **Total** | **26.18** | **25.16** | **26.54** | **27.32** | **28.93** | **31.32** | **32.26** | **34.35** |

Source: BBS, 2012

### 1.2.3 Bangladesh's position in world rice production

Paddy is grown in over 100 countries worldwide and on every continent except Antarctica(FAO,2011). The major producers are China, India, Vietnam, Bangladesh, Thailand, Indonesia, Myanmar, Brazil and Japan. At least 114 countries grow rice and more than 50 have an annual production of 0.10 million metric tonnes or more. Asian farmers produce about 90% of the total, with two countries, China and India, growing more than half of the total crop. For most rice-producing countries where annual production exceeds 1 million metric tonne, rice is the staple food. World top 10 rice producing countries are presented in Table 1.3.

**Table 1.3 Top 10 rice producing countries of the world**

(In million metric tonnes)

| Countries | 08/09-10/11 Average | 2011/12 Estimated | 2012/13 forecast |
|---|---|---|---|
| China | 134.4 | 138.7 | 139.5 |
| India | 94.8 | 103.4 | 105.0 |
| Indonesia | 40.2 | 42.2 | 42.8 |
| Bangladesh | 32.4 | 33.7 | 34.5 |
| Viet Nam | 26.2 | 28.2 | 28.3 |
| Thailand | 21.9 | 20.9 | 23.2 |
| Myanmar | 19.4 | 18.9 | 19.5 |
| Philippines | 10.8 | 11.1 | 11.5 |
| Japan | 7.8 | 7.6 | 7.6 |
| Brazil | 8.1 | 9.1 | 7.8 |

Source: FAO, 2011

### 1.2.4 Foodgrain production and requirement

The country is still not in a position to produce domestically her total requirement of foodgrain. Table 1.4 presents foodgrain requirement, net production and import/donation situation of Bangladesh. It is clear from the table that there remained a gap between foodgrain requirement and net total production. Thus every year the country had to import to fill the gap. The quantity of import/donation kept on increasing over the years although net production also increased.

## Table 1.4 Food grain production and requirement 1989-90 to 2020-21

(Thousand Metric Tonns)

| Year | Mid-yr population (Million) | Foodgrain require-Ment | Production | | | | Net total production | Import/ donation (rice+ wheat) |
|---|---|---|---|---|---|---|---|---|
| | | | Rice | wheat | Maize | Total | | |
| 1989-90 | 108.90 | 18029.60 | 17710.00 | 890.00 | 3.30 | 18603.30 | 16449.04 | 1533.00 |
| 1990-91 | 111.00 | 18377.28 | 17785.00 | 1004.00 | 3.00 | 18792.00 | 16615.89 | 1577.00 |
| 1991-92 | 113.00 | 18708.40 | 18255.00 | 1065.00 | 3.00 | 19323.00 | 17085.4 | 1564.00 |
| 1992-93 | 115.00 | 19039.52 | 18341.00 | 1176.00 | 7.00 | 19524.00 | 17263.12 | 1183.00 |
| 1993-94 | 117.00 | 19370.65 | 18041.60 | 1131.00 | 15.00 | 19187.60 | 16965.68 | 966.00 |
| 1994-95 | 119.00 | 19701.77 | 16832.70 | 1245.00 | 29.10 | 18106.80 | 16010.03 | 2566.00 |
| 1995-96 | 122.10 | 20215.01 | 17687.00 | 1369.00 | 32.00 | 19088.00 | 16877.61 | 2427.00 |
| 1996-97 | 124.30 | 20579.24 | 18880.00 | 1454.00 | 40.70 | 20374.70 | 18015.31 | 967.00 |
| 1997-98 | 126.50 | 20943.48 | 18861.71 | 1802.80 | 65.30 | 20729.81 | 18329.3 | 1961.00 |
| 1998-99 | 128.10 | 21208.37 | 19904.58 | 1908.40 | 84.50 | 21897.48 | 19361.75 | 5491.00 |
| 1999-00 | 129.80 | 21489.83 | 23067.00 | 1840.00 | 120.70 | 25027.70 | 22129.49 | 2104.00 |
| 2000-01 | 131.50 | 21771.28 | 25085.00 | 1673.00 | 149.20 | 26907.20 | 23791.35 | 1554.00 |
| 2001-02 | 133.45 | 22094.13 | 24300.00 | 1606.00 | 172.40 | 26078.40 | 23058.52 | 1799.00 |
| 2002-03 | 135.00 | 22350.75 | 25189.85 | 1596.70 | 117.30 | 26903.85 | 23788.38 | 3221.00 |
| 2003-04 | 136.20 | 22549.42 | 26189.40 | 1253.30 | 241.00 | 27683.70 | 24477.93 | 2799.00 |
| 2004-05 | 138.05 | 22855.71 | 25156.00 | 976.00 | 356.00 | 26488.00 | 23420.69 | 3375.00 |
| 2005-06 | 139.10 | 23029.55 | 26530.00 | 735.00 | 522.00 | 27787.00 | 24569.27 | 2562.00 |
| **Projected Population, Foodgrain Requirement and Production** | | | | | | | | |
| 2015 | 156.70 | 25943.42 | 31550.00 | 1600.00 | 550.00 | 33700.00 | 29797.54 | |
| 2020 | 166.90 | 27632.12 | 32800.00 | 1600.00 | 600.00 | 35000.00 | 30947.00 | |

Source: BBS, 2005

Note:

i. Foodgrain Requirement is calculated @16 ounce (453.66) per day per head from1989-90 to 2020
ii. Net production is calculated by deducting 11.58% of total production for seed, feed &wastage as per study on 'Seed, Feed and Post Harvest losses' Ministry of Food (MOF)
iii. Population as per Bangladesh Bureau of statistics (BBS) estimation
iv. Projected Production of rice, Wheat, Maize as per Department of Agricultural Extension (DAE) estimate.

### 1.3 Food policy of Bangladesh

According to the Article-15(a) of the constitution of Bangladesh, it shall be a fundamental responsibility of the State to make safe its citizens to the provision of basic necessities of food. As per Government's Allocation of Business, it is the core duty of the Ministry of Food and Disaster Management to establish a dependable food security system for the nation. The Government of Bangladesh is firmly committed to achieve food security for all, defined at the 1996 World Food Summit as: access by all people at all times to the food needed for an active and healthy life. This stipulation is also reflected in all the development plans of the Government. The present food policy was developed in the light of the recently adopted Poverty Reduction Strategy Paper and also in a broader perspective according to the definition of food security as adopted in the World Food Summit. The goal of the food policy is to ensure a dependable food security system for all people of the country at all times. The objectives of the food policy are i) to ensure adequate and stable supply of safe and nutritious food ii) to enhance purchasing power of the people for increased food accessibility and iii) to ensure adequate nutrition for all (especially women and children).

#### 1.3.1 Domestic rice procurement policy

Foodgrain procurement, especially domestic procurement programmes of rice, has a fairly long history in Bangladesh. For a long time the primary objective of the procurement program was to secure enough foodgrain to feed the Public Food Distribution System (PFDS). Since 1975, however, price support became an important objective, although feeding PFDS remained an important concern (Sahabuddin and Islam, 1999). The price support program has itself evolved in two phases. Initially, the idea was to guarantee a floor price, which used to be announced just before the harvesting season. More recently, the whole system has been geared towards guaranteeing an incentive price. The procurement price is now consciously related to the cost of producing foodgrain and is announced before the sowing season.

Now-a-days, the government of Bangladesh procures rice through millers. Three implicit reasons are lying behind this procurement programme. These are: i). providing a reasonable price to the farmers so that production incentive is not lost, and ii) to stock rice/paddy in the government warehouses for the public food distribution programme. This procurement is effectively made through the rice millers. Government declares a procurement price for rice after harvest. The rice millers purchase paddy from farmers, mill the paddy and sell to the government at stated /declared procurement price. Usually, procurement price is declared for *aman* and *boro* crops as these are the two most important rice crops in Bangladesh.

In FY 2011-12 government procured 0.674 million metric tonnes of rice from the rice millers. In FY 2010-11 domestic procurement of rice from the rice millers was higher than 2011-12 which was 0.818 million metric tonnes. From 1995-96 to 2011-12 the average rice procurement from the rice millers was 0.780 million metric tonnes. Domestic procurement of rice over the years is shown in Table 1.5.

The Table shows that *boro* is the major procured rice as opposed to *aman*. Every year the government sets a target for the quantity of rice to be procured domestically. However, the fact unfortunately remains that almost every year the procured quantity of rice falls short of their target (Table 1.5).

**Table 1.5 Domestic procurement of rice from millers (1995-96 to 2011-2012)**

(In Million Metric Tonne)

| Year | Aman | | Boro | | Rice | |
|---|---|---|---|---|---|---|
| | Target | Achieved | Target | Achieved | Total Target | Total Achieved |
| 1995-96 | 0.200 | 0.042 | 0.420 | 0.417 | 0.620 | 0.459 |
| 1996-97 | 0.250 | 0.200 | 0.250 | 0.244 | 0.500 | 0.443 |
| 1997-98 | 0.300 | 0.001 | 0.400 | 0.264 | 0.700 | 0.264 |
| 1998-99 | 0.250 | 0.000 | 0.600 | 0.604 | 0.850 | 0.604 |
| 1999-00 | 0.250 | 0.235 | 0.600 | 0.600 | 0.850 | 0.835 |
| 2000-01 | 0.250 | 0.236 | 0.600 | 0.487 | 0.850 | 0.723 |
| 2001-02 | 0.250 | 0.112 | 0.700 | 0.629 | 0.950 | 0.741 |
| 2002-03 | 0.200 | 0.019 | 0.850 | 0.754 | 1.050 | 0.773 |
| 2003-04 | 0.200 | 0.144 | 0.800 | 0.747 | 1.000 | 0.891 |
| 2004-05 | 0.200 | 0.000 | 1.000 | 0.931 | 1.200 | 0.931 |
| 2005-06 | 0.200 | 0.088 | 1.200 | 1.040 | 1.400 | 1.128 |
| 2006-07 | 0.200 | 0.163 | 1.200 | 0.706 | 1.400 | 0.869 |
| 2007-08 | 0.200 | 0.000 | 1.400 | 1.168 | 1.600 | 1.168 |
| 2008-09 | 0.200 | 0.163 | 1.198 | 1.196 | 1.398 | 1.359 |
| 2009-10 | 0.300 | 0.015 | 1.150 | 0.563 | 1.450 | 0.577 |
| 2010-11 | * | * | 0.819 | 0.818 | 0.819 | 0.818 |
| 2011-12 | 0.350 | 0.350 | 1.000 | 0.324 | 1.350 | 0.674 |

Source: DG Food, 2012

*Procurement was not made in aman season in 2010-11

### 1.3.2 Public food distribution

Bangladesh is a disaster-prone country. United Nations Development Programme (UNDP) has identified Bangladesh as the most vulnerable in the world to tropical cyclones and the sixth most vulnerable country to floods. Disasters have crucial implication for agricultural production, lives and livelihoods of huge numbers of population. It is, therefore, to ensure food security and nutrition government provide policy support directly or indirectly to increase production. As well government needs to collect rice from millers due to three reasons namely; i) provide fair price to farmers, ii) need to procure a huge amount for ensuring food security to the vulnerable people of the society, iii) facing emergency situation (if any). Every year on average 1.122 million metric ton rice need to distribute for ensuring food security. In this regard rice millers play a crucial and supportive role by providing processed rice to the government as well they sell their rice to open market. In FY 2011-12, total rice distribution through public food distribution system was 1.337 million metric tonnes.

**Table 1.6 Distribution of rice (2000-01 to 2011-12) under public food distribution system (PFDS)**

(In million metric tonne)

| *Year* | **Monetized Channels of PFDS** | **Non-Monetized Channels of PFDS** | **Total** |
|---|---|---|---|
| 2000-2001 | 0.128 | 0.855 | 0.984 |
| 2001-2002 | 0.128 | 0.520 | 0.648 |
| 2002-2003 | 0.316 | 0.445 | 0.761 |
| 2003-2004 | 0.146 | 0.482 | 0.628 |
| 2004-2005 | 0.389 | 0.713 | 1.102 |
| 2005-2006 | 0.226 | 0.782 | 1.008 |
| 2006-2007 | 0.579 | 0.709 | 1.288 |
| 2007-2008 | 0.419 | 0.662 | 1.081 |
| 2008-2009 | 0.355 | 1.402 | 1.757 |
| 2009-2010 | 0.487 | 0.817 | 1.304 |
| 2010-2011 | 1.210 | 0.360 | 1.570 |
| 2011-2012 | 0.513 | 0.824 | 1.337 |

Source: DG Food, 2012

**Note:** Monetized Channels of PFDS: Essential Priorities, Other Priorities, Large Employers, Open Market Sales
No Monetized Channels of PFDS: Food for Works, Vulnerable Group Feeding (VGF), Vulnerable Group Development (VGD), Gratuitous Relief (GF), others

### 1.4 Role of rice mills

Rice millers have a crucial role to play in the processing of paddy. For some time from the past, the government reliance on rice millers is increased for procurement of rice through them at the declared prices. Paddy in its raw form cannot be consumed by human beings. It needs to be suitably processed for obtaining rice. Rice milling is the process which helps in removal of hulls and barns from paddy grains to produce polished rice. Rice forms the basic primary processed product obtained from paddy and this is further processed for obtaining various secondary and tertiary products. The huge quantity of paddy, produced in Bangladesh, is largely processed to polished rice by different types of mechanized rice mills, popularly known as Engelberg, Major and Auto rice mills (ARM), having different capacities, spreading through the country. Besides, village level processing can also be found in rural communities. The milling outturn (67-70%) of traditional village milling process is quite impressive in comparison to modern rice milling.

#### 1.4.1 Rice milling process

Milling is a crucial step in post-harvest processing of rice. The basic objective of a rice milling system is to remove the husk and the bran layers, and produce an edible, white rice kernel that is sufficiently milled and free of impurities. Most rice varieties are composed of roughly 20% rice hull, 11% bran layers, and 69% starchy endosperm, also referred to as the total milled rice. Total milled rice contains whole grains or head rice and broken. The by-products in rice milling are rice hull, rice germ and bran layers, and fine broken. The basic rice milling processes consist of (IRRI 2009) the following activities:

1. Pre Cleaning: Removing all impurities and unfilled grains from paddy

2. De-stoning: Separating small stones from paddy
3. Parboiling (Optional): Helps in improving the nutritional quality by gelatinization of starch inside the rice grain. It improves the milling recovery percent during de shelling and polishing / whitening operation
4. Husking: Removing husk from paddy
5. Husk Aspiration: Separating the husk from brown rice/unhusked paddy
6. Paddy Separation: Separating the un husked paddy from brown rice
7. Whitening: Removing all or part of the bran layer and germ from brown rice
8. Polishing: Improving the appearance of milled rice by removing the remaining bran particles and by polishing the exterior of the milled kernel
9. Length Grading: Separating small and large brokens from head rice
10. Blending: Mixing head rice with predetermined amount of broken, as required by the customer
11. Color sorter: Detect color defects of rice
12. Weighing and bagging: Preparing the milled rice for transport to the customer

### 1.4.2 Parboiling of paddy

Rice Milling unit could be of two types: Parboiled and Raw. Raw rice is derived from paddy by de-husking (removing husk) and polishing (removing bran). Parboiled Rice also involves de-husking and polishing however, before this paddy is boiled and dried. Parboiling makes rice easier to process, improves its nutritional profile, and changes its texture. Parboiling rice drives nutrients, especially thiamine, from the bran into the grain, so that parboiled white rice is 80% nutritionally similar to brown rice. Most of the Bangladeshi people are habituated to parboiled rice.

Parboiling is a treatment of hydrothermal of rough rice prior to milling. Parboiling affects the cooking, storage, milling and ultimately consumer's preference of rice. Parboiling process rough paddy is soaked, steamed, and dried before milling (Datta, 1981). In Europe and the United States, parboiling is done with modern equipments but various methods are used in Bangladesh, India, Myanmar, Pakistan and Sri Lanka. In many areas, crude methods are still used. In different countries many traditional and modern parboiling processes have been used. The most conventional method of parboiling consists of soaking the rough paddy and then steaming it. The parboiled paddy is then dried in the sun. The process takes from 24 hours to several days depending on the weather. Clean water and paddy free of foreign matter is taken care. But in auto rice milling sun drying is not needed. According to (Datta, 1981) there are three important steps for parboiling are:

- Soaking of rough rice in water to increase its moisture content to about 30%.
- Heat treating wet rough rice, usually by steam, to complete the physicochemical changes.
- For safe milling the rough rice is drying to a moisture level.

The advantages of parboiling (Datta, 1981):

- Easy dehulling.
- Reduction of broken grains during milling of the grains is strengthened during parboiling.
- Harder grains are less vulnerable to insect attack during storage.
- Parboiled milled rice is more in vitamins B than milled raw rice.
- Cooked parboiled rice is less sticky than freshly harvested raw rice.

The disadvantages of parboiling:

- Parboiled rice tends to become rancid during storage.
- Processing and cooking long time is required.
- Additional cost (and more energy) is required in the drying operation following parboiling.
- Parboiled rice requires more energy to achieve the same degree of milling (Datta, 1981).

**1.5 Milling type of Bangladesh**

Long gone are the days of 'dheki' (a wooden device for husking paddy to make rice in most of the rural households) and 'chatals' (traditional sun-drying husking mills) are following suit. Automatic Rice-processing Mills (ARMs) have already become the prominent players in the rice processing industry of Bangladesh. New ARMs are emerging at an increasing rate than ever, leaving small and medium husking mills (chatals) in a tight corner.

Presently, there are approximately 16,400 chatals, 420 semi automatic rice mills and less than 400 fully automatic rice mills operating in Bangladesh. However, the market share of chatals is shrinking at an ever-increasing rate. These traditional husking mills are either moving towards automation or pulling themselves out of business altogether. ARMs, however, have been around in Bangladesh since the early 2000s. As per the daily newspaper, 'The Daily Star' article, in 2005, there were only 200 semi-automatic and automatic rice mill – which has tripled now.

Output from the traditional mills range from 52% to 54% of paddy intake while it ranges from 62% to 68% of paddy intake for ARMs. Traditional rice mills uses steel hullers which increase broken rice. The ARMs on the other hand uses rubber roll sellers & other improved machines for less broken rice. Sun drying is required in a vast flat land in traditional mills which is both seasonally dependent and costly while for ARMs, sun drying is not required. Parboiled rice automatically goes into dryer unit for drying which can be accommodated within a little land. It usually takes 2 days to complete a production batch for the traditional mills. A production batch can be processed within 12 to 14 hours for ARMs. No varieties of rice-making are possible as no further processing can be performed in the traditional rice mills. It can produce many varieties of rice ranging from thick puffed rice to thin food rice (miniket). Some machines are specially installed to make rice thinner. Coarse bran is produced as by-product which can only be used as animal or fowl feeds. Several bran types including a fine one is produced in different milling steps. The fine bran is further processed to make bran oil in such processing mills. Very low electricity consumption and largely labor intensive. However, for ARM high level of electricity consumption and reduced manpower is required but in automatic rice processing is highly capital intensive.

Mechanized rice milling started in this part of the sub-continent quite a long time back and is regulated by a similarly old legal instrument titled “The Bengal Rice Mills Control order, 1943”, which came into force on 20th December, 1943. During that time single pass rice mills, an adaptation of the “Engelberg” coffee hauler, was popularly used for milling parboiled rice. The rice growing countries, using these iron haulers once, have gradually shifted to more sophisticated milling system, due to high breakage of paddy grain, resulting very poor rice recovery (53-55%), except Bangladesh and many African countries, where, even today, single pass mills are widely in operations and being established every year. In many countries including India, Engelberg mills can no longer be licensed to operate or commercial mills.

The rice mills under the Department of Food are generally classified as Husking rice mills, Semi-auto rice mills and Auto rice mills and the numbers are 14239, 457 and 142 respectively with a total fortnight capacity of 0.63 million metric tonne (DG Food, 2007). In addition there are about 0.10 million traditional Engelberg type rice huller in the country. The number of semi-auto and auto rice mills have increased in recent time and estimated about 650 and 350 respectively (DG, 2011). With the increasing number of semi-auto and auto rice mills technological change is evident among these categories of rice mills in recent time. The number of husking rice mills is shrinking and the businesses are shifted either to semi-auto or auto rice mills. No technological changes are observed in husking rice mills and still using age old machines techniques. The ARMs are mostly underutilized in terms of capacity utilization and potential operations days per year.

### 1.5.1 Commercial milling

Commercial milling systems mill the paddy in stages, and hence are called multi-stage or multi-pass rice mills. The objective of commercial rice milling is to reduce mechanical stresses and heat buildup in the grain, thereby minimizing grain breakage and producing uniformly polished grain.

**Table 1.7 Number & different types rice mills in Bangladesh and their capacity (2011)**

| Sl. No. | Division | Number of Mills | | | | Fortnightly milling capacity (MT) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Husking | Major | Auto | Total | Husking | Major | Auto | Total |
| 1 | Rajshahi | 10,964 | 25 | 120 | 11,109 | 442,009 | 1,831 | 19,801 | 463,641 |
| 2 | Dhaka | 2,301 | 42 | 109 | 2,452 | 121,399 | 3,453 | 14,361 | 139,213 |
| 3 | Khulna | 1,990 | 20 | 9 | 2,019 | 75,087 | 1,408 | 2,430 | 78,925 |
| 4 | Chittagong | 365 | 17 | 69 | 451 | 24,515 | 1,217 | 10,564 | 36,296 |
| 5 | Sylhet | 50 | 0 | 8 | 58 | 2,381 | 0 | 1,179 | 3,560 |
| 6 | Barisal | 19 | 11 | 0 | 30 | 920 | 561 | 0 | 1,481 |
| **Total** | | **15,689** | **115** | **315** | **16,119** | **666,311** | **8,470** | **48,335** | **723,116** |

Source: DG Food, 2011

The rice milling facility comes in various configurations, and the milling components vary in design and performance. "Configuration" refers to how the components are sequenced. A modern commercial mill has three basic stages,

- the husking stage,
- the whitening-polishing stage, and
- the grading, blending, and packaging stage.

In modern rice mills, many adjustments (e.g. rubber roll clearance, separator bed inclination, feed rates) are automated for maximum efficiency and ease of operation. The whitener-polishers are provided with gauges that sense the current load on the motor drives which gives an indication of the operating pressure on the grain. This provides a more objective means of setting milling pressures on the grain (IRRI, 2009)

A large quantity of rice is lost during the milling process. So milling requires careful planning and use of properly designed and operated equipment. A modern rice milling operation should:

- To produce maximum yield of edible rice.
- Produce the best possible quality of rice.
- Minimize losses.
- Minimize the processing cost (Datta, 1981)

The various construction requirement of an improved rice milling unit are as follows:

i. Raw paddy warehouse

ii. Cleaning unit

ii.. Drier and necessary supporting structures such as, boiler /blower system etc.

iv. Milling section

v. Finished product stores

vi. Machine rooms

vii. Auxiliary structures such as office watch and ward etc.

The size and civil cost of these structures depend on the production capacity of the rice mills.

### 1.5.2 Types of commercial rice mills

Commercial Rice mills in Bangladesh are classified as: Traditional rice mills, Husking rice mills, Semi-Automatic rice mills and Automatic rice mills. Traditional rice mills are those commercial rice mills, which are operated at village level using simple traditional technology and local made devices. The rice are parboiled and dried traditionally. The process involves cleaning of paddy, soaking, parboiling (traditional), sun drying, and milling with Engel burg huller, aerating and bagging.

Husking rice mills have drying floor for sun drying of rice, well-built warehouse, traditional drum boilers for steaming, boiling houses and automatic milling machine fitted with screening net. The process involves cleaning of paddy, steaming, steeping, sun drying, milling with Engel burg huller, aerating and bagging. Boiler in husking mills is not standard. There is no system of measuring steam pressure and consequently, over and under steaming often affects the quality of rice. Steeping in this system consumes much time. Drying is not uniform as it is done on yard by sun. Engel burg huller produces more broken and under polished rice. Bran and husk are also mixed together. Rice produced in this system has less storage value and vulnerable to insect-pests and microorganism, and off-colored within a year.

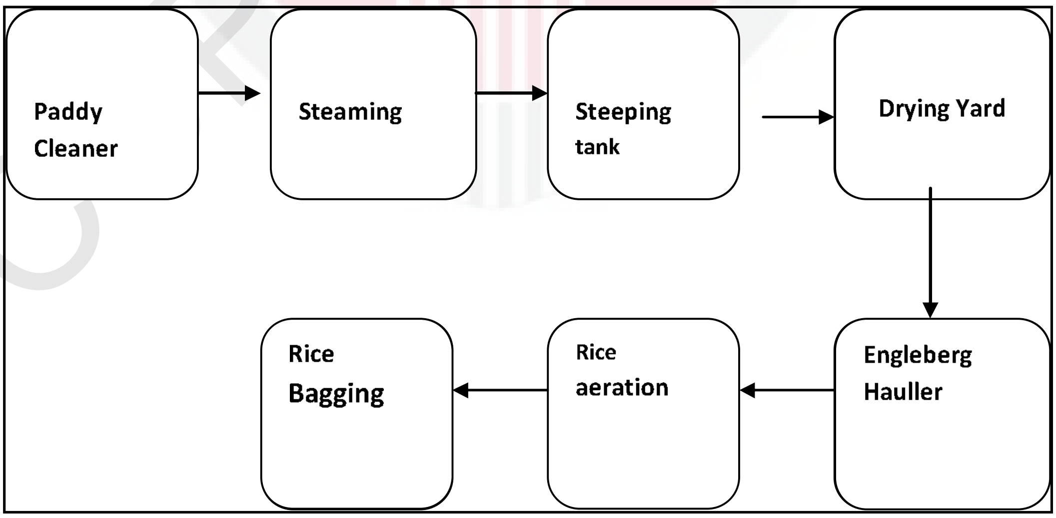


**Figure 1.4 Flowchart of husking mills in Bangladesh**
Source: DG Food, 2008

Semi-auto rice mills are those in which processing operations of rice are done with either improved or modern boiler, dryer and milling device (Farouk & Islam, 1994). The process involves cleaning of paddy, steaming, mechanical drying, milling with rubber-roll huller, rubber polishing, aerating, bagging and weighing. Rice produced in semi-automatic rice mill is well polished and less broken. Husk and bran are obtained separately, and have better use in Briquetting and edible oil extraction (Farouk & Islam, 1994). The flow chart of a semi-auto rice mill operating in Bangladesh (Farouk & Islam, 1994) is provided in Figure 1.5.

ARMs perform mechanically all operations such as cleaning, steaming, drying, milling, polishing and grading (Kapur, 2003). Unlike other rice mills, these mills do not require any drying floor. The process involves cleaning of paddy, steaming, mechanical drying, milling with rubber-roll huller, rubber polishing, paddy separator, stone separator, black rice sorter, cracked and discolored grain sorter, sieving for broken rice, aerating, bagging and weighing. ARMs produce best quality properly graded rice. Similar to semi-auto rice mills husk and bran are obtained separately, and have better use in Briquetting of rice husk and edible oil extraction from bran. Quality bran is obtained from auto rice mills, where polisher is used. From this bran high quality crude oil can be extracted. The flow chart of auto rice milling is given below (Kapur, 2003). The flow sheet of an auto rice milling is as follows:

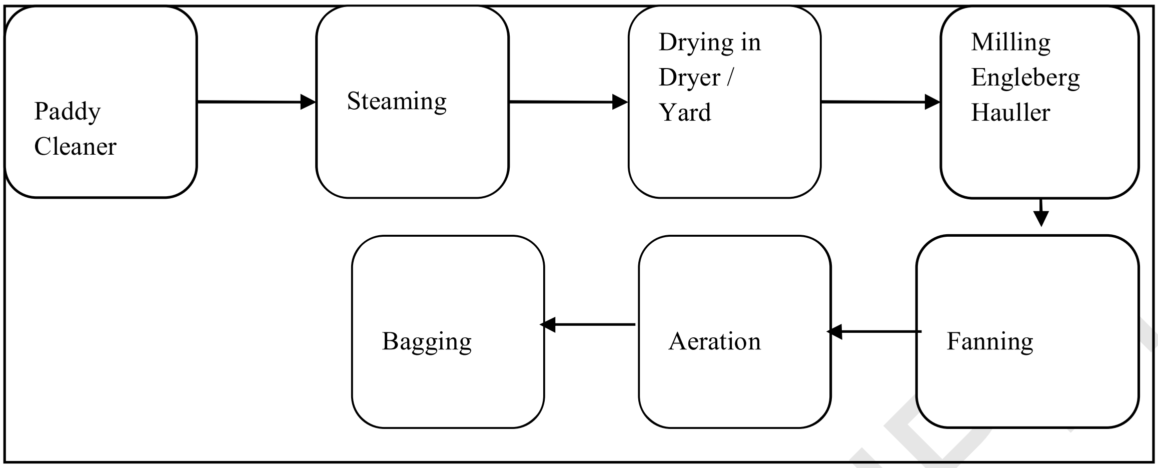


**Figure 1.5 Flowchart of semi auto rice mills in Bangladesh**
Source: DG Food, 2008

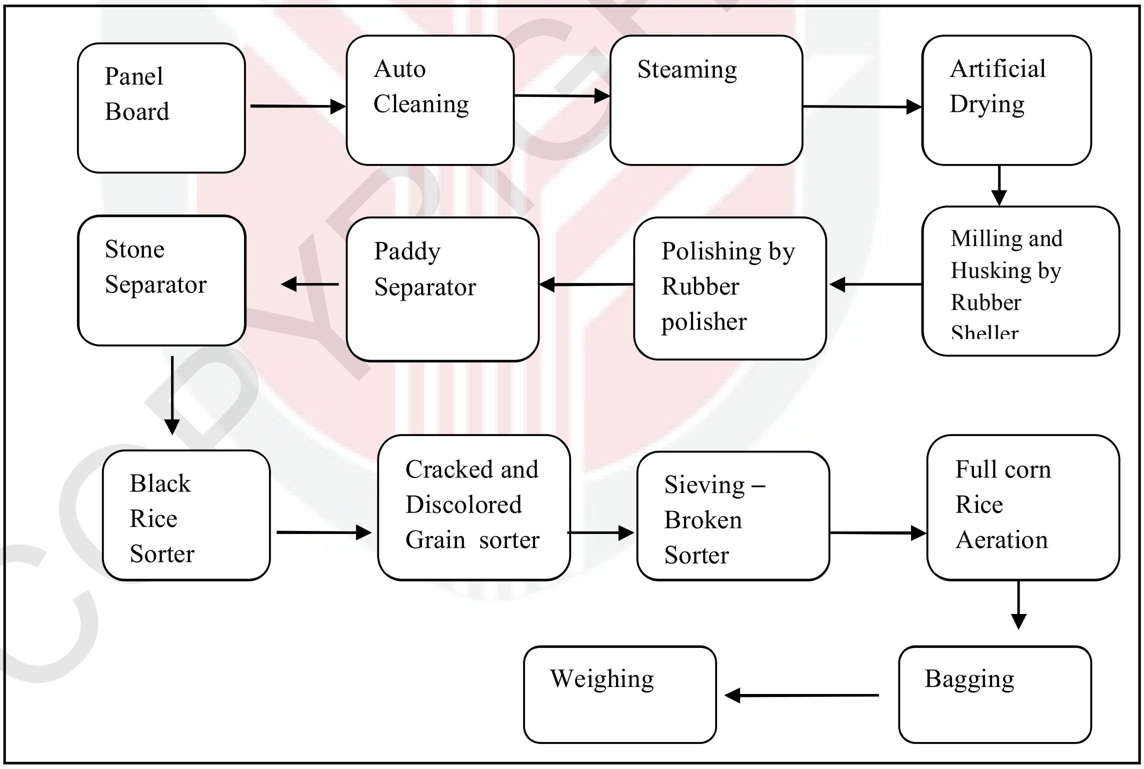


**Figure 1.6 Flowchart of automatic rice mills in Bangladesh**
Source: DG Food, 2010

## 1.6 Processing sector

The processing sector is divided into commercial and non-commercial. Non-commercial sector referred to home pounding in *dheki (*traditional equipment of paddy husking). The commercial sector covers large mills and the small husking machines. The large rice mills are characterized by equipment of several decades old. The industry is almost stagnant with respect of growth of new firms, modernization and expansion of existing firms. But the growth of husking machines is tremendous throughout the country. Almost all the mills owned steam engine which is fired by rice husks and most of them are old, purchased from processing plants in tea gardens. Some rice mills are also powered by diesel engines and electricity. In all establishments parboiling plants are powered by steam engines. The large mills do not provide custom milling services for the private traders. However, they process paddy supplied by the government. On average the mills purchased larger share of paddy from the traders at mill premises and a small portion from farmers directly. Paddy is purchased in cash and sometimes short term advances are made to traders to purchase paddy. The millers sold rice mainly to the government, traders in consuming markets in different areas of the country and sometimes small quantities to local *aratdars* (Commission agent who facilitate sales in lieu of commission).

## 1.7 Losses in milling

During the milling processing a large quantity of rice is lost. So it requires careful planning and use of proper designed and operated equipment. Good rice milling operation should:

- Produce the maximum yield of edible rice
- Obtain the best possible quality

- Minimize the losses
- Minimize the processing cost

Losses in the milling process are caused by poor technical performance of milling machinery, resulting in poor milling yields. Engelberg type steel hullers have been eliminated from different countries as it breaks the grain in the milling process and yields only 53% milled rice. India is reported to have outlawed the Engel burg rice hullers in favor of more efficient mills. However, in Bangladesh, the Engelberg type steel rice hullers are still predominant in rice milling. At present, about 95% milling is done by Engelberg steel huller in Bangladesh and at least 2 % rice is lost due to use of Engelberg steel hullers (Baqui et al., 1994). Bangladesh is now producing about 27 million metric tonnes of rice; in national context the loss of rice amounts to 0.053 million metric tonne. Use of rubber-roll hullers also produces good quality rice and rice byproducts that can be sold at higher prices.

Traditional Rice mills do not use boilers and furnaces for parboiling of paddy causing a huge loss of rice husk as fuel. Even most of the steam boilers and furnaces are not insulated and of recommended standard, therefore, caused a loss in thermal efficiency and high consumption of rice husk as fuel. It also imposes serious consequences leading to burning injuries, even death to boiler operators. About 60 percent rice husk is saved if standard efficient boilers are used (Farouk & Islam, 1994). This saving of rice husk can be utilized for heated air mechanical dryers during monsoon when natural sun drying becomes impossible.

### 1.8 Problem of statement

For the last few years Bangladesh has been producing 25-27 million metric tonne of paddy every year. Paddy is processed into polished rice by 91,423 rice husking mills, 475 semi-auto rice mills, 315 auto rice mills and 100,000 traditional mills with Engelberg hullers. Currently, about 95% milling of the paddy is done by less efficient Engelberg hullers and incur a substantial amount of loss in recovery of whole (polished) rice. Conversion of Engelberg huller to rubber roll sheller could save 2-4% of whole rice loss with no broken rice. Considering 27 million metric tonnes of paddy annually could save 0.648 million tonnes of milled rice, i.e. almost quarter of the total whole rice deficit of the country. About 0.5 million metric tonnes of rice is wasted every year due to inefficient boiler and huller in the rice mills.

In addition to this mechanical loss, further losses in the milling process are caused by poor technical performance of milling machinery, or operators' ineptitude, resulting in poor milling yield. In Bangladesh Engelberg machine is still predominant, and for milling paddy, requires manual parboiling and drying. If the derived potential loss in drying is 7%, milling the same in Engelberg will result in an additional 7% loss or a total of 14% loss in the processing plant.

Processing loss in auto rice mills is much lower. There is virtually no loss in the parboiling and drying process as there is no involvement of drying yard as parboiling and drying are done by boiler and furnaces. Moreover, processing loss is also lower as it is processed by rubber roller huller. In ARMs, about 60% rice husk is saved if standard efficient boilers are used (Farouk et. al. 2002). Engelberg type rice mill results in only 53% milled rice. Moreover, it also results considerable breaking of grains in the milling process. Whereas ARMs provide good quality milled rice to the extent of 67 to 70% with no breakage. There are other advantages of auto rice mils. Milled rice is of much better quality fetching higher market price. Considerable amount of husk is saved which can be used for heated air mechanical dryers during monsoon when natural sun drying becomes impossible, Quality bran is obtained from auto rice mills, where polisher is used. From this bran high quality of crude oil can be extracted. Having seen the quality milled rice and other advantages, consumers are becoming interested in auto milled rice. In response to this interest and demand, gradually traditional mills are being converted into ARMs. In future, the ARMs are expected to be dominating the paddy processing sector of Bangladesh.

ARMs are very capital intensive and very often require procuring funds from banks. Obtaining funds from banks takes a good deal of time. Moreover, as an industry contributing to the nation, ARMs do not get any concessionary loans. In addition, there is considerable involvement of costs in loan contracting. The great issue the ARMs are facing currently is the scarcity of electricity. Due to its scarcity, substantial cost involvement is required to buy generators and its diesel. Moreover, the default capacity is also affected due to electricity failures. One study indicated that due to shortage of electricity 60-65% of the default capacity can be exploited. All these affect production costs. Moreover, there is a fierce competition in place in procurement of paddy during lean harvest seasons; especially, during *aman* and *aus* harvesting seasons, which are heavily exposed to various natural calamities. In addition, ARMs are being built with four times the capacity of traditional rice mills while the paddy production is not increasing at the same rate; naturally resulting in low capacity utilization of the millers. It is also true that ARMs are being operated by mostly non-technical personnel who have very little knowledge of operating such highly technical equipments. Any minor glitch of any of these intricate machines can stop production altogether resulting in significant loss to the millers.

Being the staple food and a major political consideration, Government of Bangladesh (GoB) frequently disrupts the normal market mechanism by getting heavily involved in the rice procurement. Government purchases rice from the millers each year for maintenance of her stocking programme. In 2010-11 for instance, GoB had decided to collect 0.6 million metric tons of rice from the millers at a rate of Taka 29 per Kg but the market price of per kg of paddy then was Taka 17.5 and total production cost per kg rice was up to Taka 29.5. This decision had left the millers with limited margin or no margin. However, during 2011-12, average rice production costs ranged between Taka 26-27 per kg while GoB set the procurement price at Taka 28 per kg; thereby, giving easy profit opportunities for the MoF licensed millers and traders. These problems have of course a negative bearing on the operation, profitability and technical efficiency of the ARMs.

This is why a study on the profitability and technical efficiency of ARMs is worthy in the context of Bangladesh. Thus pertinent research questions for the ARMs are:

- Whether or not the mills are running profitably? Does benefit outweighs cost?
- Is the management good enough to operate the mill at optimal scale?
- Are the mills running at technically efficient level? If not, how much is the level of inefficiency and gap in the milling yield?
- What factors constrain the operation of auto rice mills?

As studies conducted in the past on auto rice mill is very scanty, it is justified to conduct a study to answer the above questions. Information on returns to scales being achieved in rice mill operations is also not available. The research questions raised above formed the basis of the present study. It is expected that the study will provide very good insight about the economics of paddy processing and technical efficiency/inefficiency of auto rice mills.

### 1.9 Objectives of the study

The overall objective of the study is an economic investigation to the ARMs to generate policy parameters so that millers and the policy planners can make use of them to improve the mill operation, pricing of the market price of rice and management of domestic procurement programme.

The specific objectives of the study are as follows:

I. To estimate cost, return and profitability of the Auto Rice Mills

II. To determine overall technical efficiency, pure technical efficiency and scale efficiency of the ARMs

III. To identify factors affecting operations of ARMs

IV. To provide policy suggestions based on results

### 1.10. Hypothesis of the study.

The following hypotheses are developed to the above research questions:

i. Rice millers are profit makers

ii. Rice millers are efficient in overall economic terms

iii. Rice millers are efficient in pure technical terms, and

iv. Rice millers are scale efficient

### 1.11 Organization of thesis

Following discussion on the background of the rice milling sector and other related aspects in the introduction, chapter II presents brief review of literature of related studies on processing economics and other related aspects of rice milling. The third chapter deals with methodology of the study where benefit cost analysis and the data envelopment analysis approach are presented. Chapter four discusses results and discussion while chapter five presents summary, conclusion and policy implications of the study.

# REFERENCES

Abdullah, A.M., Rene, S.I., Radam, A. and Haroon, M. (2002). Determining the relative efficiency of BERNAS rice mills: An application of data Envelopment Analysis (DEA). *Malaysian Journal of Agricultural Economics*, 15:25-41.

Ahamed, A. (1996). Centrifugal rice huller an active device for the maximum level of efficiency was found in year 1985 rice processing agricultural mechanization in Asia, Africa and Latin America. (AMA), vol.27(2), P. 27-32.

Alam, M.M. (2004). Technical and economic performance of some selected rice mills of Bangladesh. MS thesis, Department of farm Power and machinery, Bangladesh Agricultural University, Mumensingh, Bangladesh.

Amrutha, C.P., 1994, Economics of processing paddy into rice, poha, murmura and popped rice. M.Sc. (Agri.) Thesis, Univ. Agric.Sci. Dharwad (India).

Appiah, F., Guisse, R. & Dartey, P.K. A. (2011). Postharvest losses of rice from harvesting to milling in Guana. Journal of Stored Products and Postharvest Research, 2 (4): 64-71.

Bala B. K**.** (2010). Post harvest loss and technical efficiency of rice, wheat and maize production system: assessment and measures for strengthening food security. National Food Policy Capacity Strengthening Programme. Physical Location: FPMU Documentation Center Classification Number: O-2010-30. http://www.nfpcsp.org/agridrupal/content/post-harvest-loss-and-technical-efficiency-rice-wheat-and-maize-production-system-assessment.

Banker, R.D., Charnes, A & Cooper, W.W. (1984). Some models for estimating technical and scale efficiencies in data envelopment analysis. *Management Science,* 30: 1078-92.

Baqui, M. A., Miah, M. A. K. & Ahmed, A. (1994), "Processing Technologies of Rice in Bangladesh, Suggested Technologies and Policy Issues Needed to Produce Finished Improved Quality of Rice Both for Local and International Market", A Paper Presented in the National Workshop on Post Harvest Processing and Preservation of Agricultural Product, Its Present Status and Future Strategies in Bangladesh, held a t BARC, 26-27June .

Bawa, R.S. and Kainth, G. S. (1989). Cost and returns analysis of rice milling industry. *Indian Journal of Agricultural Economics*, 44: 326-327.

BB (2011). Bangladesh Bank (http://www.bb.org.bd/econdata/exchangerate.php

BBS (2005). Bangladesh Bureau of Statistics, Department of Agricultural Extension and Ministry of Food, Government of the People's Republic Of Bangladesh.

BBS (2008). Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, Government of the People's Republic Of Bangladesh.

BBS (2009). Statistical Pocket Book of Bangladesh, Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, Government of the People's Republic of Bangladesh.

BBS (2010). Yearbook of Agricultural Statistics of Bangladesh, Finance Division, Ministry of Finance, Government of the People's Republic of Bangladesh.

BBS (2011). Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, Government of the People's Republic of Bangladesh.

BBS (2012). Yearbook of Agricultural Statistics of Bangladesh, Finance Division, Ministry of Finance, Government of the People's Republic of Bangladesh.

Bekele, T. & Belay. K. (2007). Technical Efficiency of the Ethiopian Grain Mill Products Manufacturing Industry. *Journal of Rural Development,* 29(6): 45-65.

Boussofiane, A., Dyson, R., Thanassoulis, E. (1991). Applied data Envelopment Analysis. *European Journal of Operational Research*, 52: 1-15.

BRRI & FAO (1985). A study on farm and village level post harvest rice loss assessment in Bangladesh. Field document No. 8, Bangladesh Rice Research Institute (BRRI) Gazipur.

Charnes, A. Cooper, W.W. and Rhodes, E (1981) Evaluating programme and managerial efficiency: an application of data envelopment analysis to programme follow through. Management Science 27, 668-332.

Charnes, A., Cooper, W.W, & Seiford, L.M. (1994). Data Envelopment Analysis: Theory, Methodology and Applications. Norwell, MA: Kluwer.

Chowdhury, N. (1992). Rice Markets in Bangladesh: A study in structure, conduct and performance, Dhaka: USAID, Bangladesh.

Coelli, T. J. & Perelman, S. (1996). Efficiency measurement, multiple-output technologies and distance functions: with applications to European railways", *CREPP Discussion Paper* No. 96/05, University of Liege, Liege.

Coelli, T.J. (1995). Measurement and sources of technical inefficiency in Australian electricity generation. A paper presented at the New England Conference on Efficiency and Productivity, University of New England, Armidale, November 23-24.

Coelli, T.J. (1996). A guide to DEAP version 2.1: A data envelopment analysis (computer) programs', CEPA Working Paper 96/08, Department of Econometrics, University of New England, Armidale.

Coelli, T.J., Rao, D.S.P. & Battese, G.E. (1998). An introduction to efficiency and productivity analysis. Kluwer Academic Publishers.Boston, MA.

Datta, S. K. (1981). Principles and Practices of Rice Production. John Wiley, New York.

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

DG Food (2007). Management Information System, Directorate General of Food, Food Division, Ministry of Food and Disaster Management, Government of the People's Republic Of Bangladesh.

DG Food (2008). Management Information System, Directorate General of Food, Food Division, Ministry of Food and Disaster Management, Government of the People's Republic Of Bangladesh.

DG Food (2010). Management Information System, Directorate General of Food, Food Division, Ministry of Food and Disaster Management, Government of the People's Republic Of Bangladesh.

DG Food (2011). Management Information System, Directorate General of Food, Food Division, Ministry of Food and Disaster Management, Government of the People's Republic Of Bangladesh.

DG Food (2012). Management Information System, Directorate General of Food, Food Division, Ministry of Food and Disaster Management, Government of the People's Republic Of Bangladesh.

Dholakia, R.R. & Zaman, Z. (2004). Shahazadi Rice Mill. *AIUB Journal of Business and Economics*, 3(3): 73-83.

Dobermann, A. (2004). A critical assessment of the system of rice intensification (SRI). *Agricultural Systems*, 79: 261-281.

FAO (2011). Food Outlook, Trade and Market Division of Food and Agricultura Organization Nations Under Global information and Early Warning System, Rome, Italy.

Fare, R., Grosskopf, S. & Lovell, C.A.K. (1985), The measurement of efficiency of production (Kluwer-Nijhoff, Boston, MA).

Fare, R. & Lovell, C.A.K. (1978). Measuring the technical efficiency of production. *Journal of Economic Theory*, 19: 150-162.

Farouk, S.M. & Islam, M.R. (1995). Study of the processing technology and management systems for rice mills in Bangladesh. Bangladesh Agricultural University Research Project. No. 9, 354.

Farouk, S.M. and Islam M.R. (1994). Study of the processing technology and management systems for rice mills in Bangladesh. Bangladesh Agricultural University Research Project. No. 8, pp.462-471.

Farrell, M. J. (1957). The Measurement of productive efficiency", J Roy Statistical Society, series A, CXX, Part 3, pp. 253-290.

Gautam, D.S., Singh, N. & Nahatker S.B. (1988). Cost benefit analysis of paddy processing plants in rice bowl of India, *Agricultural Marketing,* 31(3): 24-36.

Gujral, H. S, Singh, J., Sodhi, N. S. & Singh, N (2002). Effect of milling variables on the Degree of milling of unparboiled and parboiled rice. International Journal of Food Properties, 5(1), 193-204.

Gupta, V.K. & George, P.S. (1974). Modernization in the rice milling industry in Punjab. *Indian Journal of Agricultural Economics*, 29: 215-217.

Gupta, V.K., Mathur, D.P. & Krishna, P.V. (1974). Stages of modernization in the rice milling industry. IIM publications, Ahmedabad.

Hanh, R.L.T. (2009). Impact of financial variables on tthe production efficiency of Pangasius farms in An Giang Province, Vietnam. Master's Thesis, The Noregeian College of Fshery Sciences, University of Tromso, Norway & Nha Trang University Vietnam.

Haque, A. & Quasem, M.A. (1997). Rice post- harvest practices and loss estimation in Bangladesh-Part-III; parboiling to milling. *AMA*, 28 (3):51-55.

Harriss, B. (1979). There is method in my madness: or vice-versa? Measuring agricultural market performance. *Food Research Institute Studies*, 17 (2): 11-19.

IRRI (2009). Rice Policy- World Rice Statistics (WRS).

Islam, M.R.(1981). Analysis of designed performance of an automatic rice mill at Sherpur, Jamalpur districts in Bangladesh. Project Report. Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh.

Ismail, R. (2009) Technical Efficiency, Technical Change and Demand for Skills in Malaysian Food-Based Industry. *European Journal of Social Sciences*, Vol. 9, No 3.

Jaforullah, M. & Whiteman, J. (1999). Scale efficiency in the New Zealand dairy industry: a non-parametric approach. *Australian Journal of Agricultural and Resource Economics,* 43(4): 523-541.

Jha, D. K. and Shrestha, R. (2006). Measuring Efficiency of Hydropower plants in Nepal using Data Envelopment Analysis. *IEEE Transactions on power system*, 21 (4):1502-1511.

Joaysena, W.V. and Ilangatilek, S.A. (1986). Losses of Rice during milling in commercial rice during milling in commercial rice mill of Sri Lanka. Agricultural Mechanization in Asia, Africa, and Latin America, 7( 3):55-70.

Kabir, H.M. (1989). Study of factors affecting parameters in existing rice processing mills. A Project Report, Department of Farm Power and Machinery, Faculty of Agricultural Engineering and Technology. Bangladesh Agricultural University, Mymensingh.

Kalirajan, K.P. & Tse, Y.K. (1989). Technical efficiency measures for the Malaysian food manufacturing industry. *The developing Economies*, XXVII (2):174-184.

Kapur, B. N. (2003). Diagnostic Study Report On Rice Milling Industry At Karnal (Haryana). Cluster Development Programme, government of India, ministry of small scale industry. Ref. No. KNL/DS/Rice-01.

Koopmans, T.C. (1951). An analysis of production as an Efficient Combination of Activities, in T.C. Koopmans , Ed., Activity Analysis of Production and

Allocation, Cowles Commission for Research in Economics, *Monograph*, No. 13, Wiley, New York.

MoF(2011). Bangladesh Economic Review, Finance Division, Ministry of Finance, Government of the People's Republic of Bangladesh.

MoF(2012). Bangladesh Economic Review, Finance Division, Ministry of Finance, Government of the People's Republic of Bangladesh.

Nayak, P. (1996). Problems and Prospect of Rice Mill Modernization: A Case Study. *Journal of Assam University*, 1 (1): 22-28.

Rahman, M. A. Miah, M. A. K. and Ahmed, A. (1996). Status of Rice Processing Technology in Bangladesh. Agricultural mechanization in Asia, Africa and Latin America, 27 (1): 46-50.

Rahman, S. (1998) ,"An Analysis of Market Structure , Conduct and Performance of Paddy Processing Indus try in Some Selected Are a s of Naogaon District", MS Thesis, Department of Cooperation and Marketing, Bangladesh Agricultural University (BAU) , Mymensingh, June.

Roslan, A. Ghaffar, T.A., Chew and Hassan, A. (1988) Drying and Milling Cost Functions of Paddy: Empirical Estimates for Government Processing Complexes in Malaysia. *Pertanika* 11(2), 283-288.

Sahabuddin, Q. & Islam, K. M. N. (1999). The domestic rice procurement program in Bangladesh-An Evaluation. FMRSP Working Paper No. 13., Food Management and Research Support Project No. 57, Ministry of Food, Government of the People's Republic of Bangladesh.

Sarker, N. N. (1985). Milling performance of some rice mills in the Mymensingh District. A Project Report No. 57. Department of Farm Power and Machinery, Faculty of Agricultural Engineering and Technology. Bangladesh Agricultural University, Mymensingh.

Sarker, N.N. & Farouk, S.M. (1989). Some factors casing rice milling loss in Bangladesh. *Agricultural Mechanization in Asia, Africa and Latin America,* 20 (2): 49-52.

Shwetha, M. K., Mahajanashetti, S. B., & Kerur, N. M. (2010). Economics of paddy processing : A comparative analysis of conventional and modern rice mills. *Karnataka Journal of Agricultural Science, 24*(3), 331-335.

Sirikanokvi, S. (1987). Technical efficiency and firm size in rice milling industry: A case study in Saraburi Province, Thailand. MS thesis, Graduate School of Thammast University, Bangkok, Thailand.

Toquero, Z. (1977). Quantitative and qualitative loss in rice production system Paper presented at Work shop on post-harvest Rice losses, Alor, star, Malaysia.

Warda (2005). Rice, a strategic crop for Food Security and Poverty Alleviation. Retrieved May www2.slu.se/cigar/CGIAR_WARDAppt 26.

Wimberley, J.E. (1972). Review storage and processing of rice in Asia, Paper presented at the Agricultural Department, IRRI, Philippines.

Wongkeawchan, J., Wiboonpongse, A., Sriboonchita, S. & Huang, WT. (2005) Comparison of technical efficiency of rice mill systems in Thailand and Taiwan. www.mcc.cmu.ac.th/agbus/data/paper/jantana_nbsp_paper.pdf/