PN-ACN-958

TECHNICAL ASPECTS OF FOOD POLICY IMPLEMENTATION IN BANGLADESH:

GRADES, STANDARDS, STORAGE AND PROCUREMENT

MAHFOOZUR RAHMAN

JUNE 2001

FMRSP Synthesis Report No 4

FMRSP Bangladesh
Food Management & Research Support Project
Ministry of Food, Government of the People's Republic of Bangladesh

International Food Policy Research Institute

This work was funded by the United States Agency for International Development (USAID)

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Contract Number: 388-C-00-97-00028-00

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The views expressed in this report are those of the author and do not necessarily reflect the official position of the Government of Bangladesh or USAID.

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FMRSP Bangladesh

Food Management & Research Support Project
Ministry of Food, Government of the People's Republic of Bangladesh

International Food Policy Research Institute

The FMRSP is a 3.5 year Project of the Ministry of Food, Government of the People's Republic of Bangladesh, providing advisory services, training and research, related to food policy. The FMRSP is funded by the USAID and is being implemented by the International Food Policy Research Institute (IFPRI) in collaboration with the Food Planning and Monitoring Unit (FPMU) of the Ministry of Food, the Bangladesh Institute of Development Studies (BIDS), the University of Minnesota and International Science & Technology Institute (ISTI).

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1. INTRODUCTION

Nothing is as fundamental to the well being of the people of Bangladesh as provisioning of adequate food. With an annual per capita food grain availability of about 188 kilograms in 2000-2001, an adequate and nutritionally balanced diet is still out of reach for a large percentage of the population. Thus, sensitiveness and implications of food policy exert an inordinate influence on the government and the civil society of Bangladesh, even as the goal of self-sufficiency in food grain production has largely been achieved since the last famine of 1974.

To address issues arising out of the chronic food shortages, the policy responses of successive governments had been twofold. Firstly, these policies helped sustain agricultural production growth by investing in irrigation, high yielding seeds, fertilizers, and agricultural extension services. The government continued at the same time to sponsor agricultural education and research, resulting in a new breed of agricultural technicians and scientists who increasingly made their mark on the production environment. Secondly, a massive public food distribution system was developed over the years with an infrastructure consisting of 5 silos, 13 Central Storage Depots and 713 Local Storage Depots, totaling a static capacity of above 1.8 million metric tons of foodgrain. The system is flexible enough to turn this capacity over twice, or even thrice, in times of emergency, as it was demonstrated during the flood years of 1988/89 and again in 1998/99.

Agricultural research and extension services, the expansion of irrigation and other measures had doubled food production in two decades, out-stripping population growth. However, such progress had not been steady or painless. Periodic but regular floods, draughts, and cyclones stress the production environment, resulting in fluctuations in production, especially in the Aman season, and create seasonal shortfalls that had to be

made up for with imports. Thus, inter-seasonal variation in the production of the main crops has been large. Poverty and malnutrition remain widespread and national per capita calorific consumption still remains unsatisfactorily low. More than fifty percent of the population remains below the poverty line. In all contexts of development effort, national food security remains, and will remain for the foreseeable future, the most important concern of the government and people of Bangladesh.

With the rise in production, food grain markets also underwent rapid growth. Not only has rice production increased dramatically, the marketed portion of produce has also increased rapidly. Boro season production has greatly reduced seasonality in prices. The standard deviation of production from long-term trends had decreased from 5.2 to only 3.3 by the 1990s. About 45 percent of Aman and 55 percent of Boro goes through the marketing channel. These huge marketable quantities of rice also imply requirements of advanced milling, storage, and other infrastructure, and a greatly enhanced need for agricultural credit, entrepreneurial skills and application of appropriate technology in every state of production and distribution. While increasing reliance is placed on the private sector for the supply side of the food economy, the government continues to play an important role in the food markets. The government of Bangladesh well recognizes the roles that it may play in the in the circumstances of the changes. The National Food Policy, 2001 paper adequately documents and precisely addresses the complex issues of food policy, where ensuring dependable food security for the people at all times remains the supreme objective. Pursuant to these policies, the government continues to play an important role in the markets. Such a role is represented by the maintenance of a national food security stock that is built up principally through internal procurement, food aid, and by imports when domestic production is hampered owing to natural disasters. In recent years, internal procurement amounted, on average, to about 0.7 million metric tons of rice, 0.4 million metric tons of paddy and 0.2 million metric tons of locally produced

wheat. The government stock averaged around 1 million metric tons in these years, representing a huge budgetary outlay.

THE TECHNICAL ISSUES

There are many technical issues involved to efficiently implement the stated policies. These include, among others: grades and standards, internal and external procurement by tenders, and storage procedures that are essential to maintain the security stock in good condition and to manage the stocks in a rational manner. Questions of export, as increasing productions are to be maintained irrespective of fluctuating domestic demands, need due attention as a viable option. These issues were addressed in various research papers, which are synthesized in these papers and abstracted under one cover. However, due to the disparate nature of the issues, these are covered as different chapters.

The paramount importance of proper grades and standards for procurement and appropriate storage management to minimize storage losses cannot be over emphasized. These concerns are well reflected by the government's National Food Policy 2001 document, which says, inter alia:

> **" 1.2.2.3 Development and Enforcement of Quality Standards**
>
> Maintenance of quality requires care at all stages of all stages of marketing operations, viz. assembling, handling, grading, processing, packaging etc. Enforcement of quality standards is important both for domestic and external trade. The demand for agricultural exports would depend on the establishment of the country as a supplier of quality products for the external markets. Despite laying down specifications of moisture content, food grains with high moisture content are being transacted, which spoils the final product. As the new varieties are being introduced, grade and standards should be fixed variety-wise to protect consumer interests. Frequent changes in grade standards should not be permitted as it creates confusion in the market and in order to transmit appropriate signals to the producers, traders and consumers.
>
> To maintain the quality standards of food commodities, the Government of Bangladesh will:

i. develop uniform grades and for agricultural commodities with appropriate legislative measures;
ii. enforce quality standards and their strict compliance
iii. train relevant agencies and persons about the quality, standard and compliance issues; and
iv. provide laboratory facilities to facilitate ensuring quality of food products"

The policies of the government regarding maintenance of public stock, state:

> "1.3.1 Public Food Grain Stock
>
> ...the government's currently stated aim in National Food and Nutrition Policy is to maintain a minimum of 800 thousand metric tons of food grains in public stock. In order to handle uncertainties of import and emergency off take requirements, the government has decided to keep 1.0 million tons of food grains in public stock, reflecting the true dynamics of stock accumulation and distribution. Usually, during domestic food grain procurement season, the public stock level exceeds the target level, while in pre-harvest period periods public stock level may go below the target level..."

It is thus adequately reflected in the national food policy document that the formulation of adequate grades and standards and enforcement thereof, are of utmost importance to the government of Bangladesh. These modern grades and standards are required for a variety of reasons ranging from internal procurement of high quality nutritious rice to international tenders where correct grades may be purchased by the government in times of shortages in the country. These grades will also help regulate the internal market to protect consumer interests as well as to transmit correct signals to the private sector for internal trade as well as for eventual export.

The government of Bangladesh also maintains a security stock of a million tons as a matter of policy. Much of it is in the form of rice. While wheat stock remains in a good condition for a longer period, milled rice is notoriously sensitive to storage conditions and has a much shorter shelf life. When the rice stock shows signs of deterioration, it is released to avoid storage losses that will eventually mean total loss of the stock. This situation hampered planned operations, besides entailing huge losses to the stockholder.

Thus modern and efficient storage is of utmost importance to hold this stock in good condition. Since the government operation is in effect a 'buffer stock' management, long storage life of the procured rice is a prerequisite to implementing government policies. In this respect, understanding the chemical changes in the food grains in government storage will be of great assistance in formulating a viable storage management policy based upon scientific basis.

Thus it is seen that there are many technical issues that need to be addressed in implementing the stated food policies of the government. Chiefly, these following pages will be devoted to grades and standards and storage management issues, though the process of standardization starts from post-harvest activities. These issues are now discussed and are organized in short chapters from 2 to 5.

2. GRADES, STANDARDS AND INSPECTION PROCEDURES OF RICE

After decades of chronic shortages, Bangladesh finally achieved self-sufficiency in rice production. In recent years, the area under rice cultivation has averaged about 10.71 million hectares with an annual production of about 29 million tons. Most of the increased production comes from the irrigated Boro season production, which has exceeded the rain-fed Aman production in the last few years. Because of high atmospheric moisture and rains, many difficulties are encountered by the farmers in the post harvest processing of Boro rice, in addition to problems of impure seed and admixtures of foreign matters in the harvested paddy. The introduction of uniform grades and standards will ensure quality production and processing of rice, thus assisting government procurement and private trade of rice.

The Bangladesh Standard Testing Institution (BSTI) has developed national grades and standards for rice and paddy. The Directorate General of Food (DGF) has formulated a single grade similar to BSTI for regular procurement of paddy and rice. BSTI grades and standards for rice and paddy are seldom used for the domestic market due to their difficulty in adoption and seem to be impractical owing to their complex nature. Thus, the BSTI standard is yet to be enforced by law, and yet remains theoretical. Grading at private sector/millers level is mostly conducted on subjectively deduced parameters.

Farmers sell about 50 percent of rice/paddy production either to the DGF or to the local market. The DGF purchases rice under a single grade standard. The grading system of such a nature does not encourage the producers and millers to produce superior quality paddy or milled rice. The existing incentives are usually given to promote quantity rather

than quality with a consequent adverse impact upon the quality of Bangladesh rice in general, and government procured rice in particular.

AN OVERVIEW OF RICE GRADING AND INSPECTION PROCEDURES IN SELECTED RICE PRODUCING COUNTRIES

Many countries in Asia have developed and implemented, while some are in the process of establishing, an effective grading system that assists in determining the value of food grains. A brief description of the grading system of Bangladesh and selected Asian countries and the USA are given below.

Bangladesh

In Bangladesh, numerous varieties of rice with varying intrinsic qualities are found in the market. Government standards of rice have a long history in Bangladesh. Standard specifications for a particular category of food item were first introduced in the country as the Bengal Food Adulteration Act 1919, the Assam Pure Food Act, 1932, the Repeal of Bengal Act IV and the Assam Act 1, 1932. In 1959, the then East Pakistan Government promulgated East Pakistan Ordinance No. LXVIII of 1959, titled as the East Pakistan Pure Food Ordinance 1959 (E. P. Ord. 1959). The main objective of the ordinance was to provide for better control of manufacture and sale of food for human consumption. The Pure Food Rules of 1967 state that food grains for human consumption shall be clean, dry and free from mold. It shall be free from damage (by insects or otherwise), bad smell, discoloration and admixture with deleterious and toxic materials. Under this ordinance there were several laws and by laws which prohibited the manufacture or sale of food that was not of proper substance and quality. The ordinance was revised in 1967 and renamed as the East Pakistan Pure Food Rules, 1967. The power of implementation was conferred to the then Health Department. The East Pakistan Pure Food Rules for food grains, cereals and their products remained unchanged after the independence of Bangladesh and were renamed as the Bangladesh Pure Food Rules,

1967. Parameters of the standards for cereal included were color, smell, taste, foreign matters, damaged grains, insects, sound grain and moisture content. Under these rules, all government procurement and import of paddy and rice were administered by the then Food Department. The Bangladesh Pure Food Rules, 1967 remained in force up to 1986. There were no separate rules for rice and paddy before 1986.

The Bangladesh Standard and Testing Institution (BSTI) adopted the "Bangladesh Standard Specifications for Grades on Milled Rice" on 18 December 1986. The draft specification was finalized by the cereals, pulses and their products sectional committee and afterwards it was approved by the Agricultural and Food Products Divisional Council of Bangladesh.

Besides BSTI standards, the Directorate General of Food (DGF) follows their own standards for procurement of paddy and milled rice, which is called the Fair Average Quality (FAQ) standard. The parameters included in the procurement standards are more or less similar to that of the BSTI. There has been no revision or modification of BSTI standards or the FAQ since their promulgation in 1986.

India

Innumerable rice varieties are abundantly grown in India, hence, varietal classifications are difficult. However, varieties became necessary for purposes of pricing as well as for adopting quality standards. Classifications such as 'Fine', 'Medium' and 'Coarse' were adopted in the early years of state trading. Later on, as availability improved, pricing, and consequently classification, became relatively intricate. More groups, such as 'Superfine', etc were then added to the existing groups.

Parameters for assessing quality and value of paddy are: foreign matter content, admixture of inferior varieties, proportion of damaged kernels and moisture content. Invariably, field paddy has a foreign matter content varying between 1.5 and 3.0 percent and moisture between 16 and 22 percent. Scented varieties are required to be placed in an

appropriate class and then allowed a premium price for their flavor. "Basmati" rice, produced in the Punjab, Haryana and Uttar Pradesh, is considered a choice variety in Bangladesh. The Food Corporation of India (FCI) and State agencies follow the Fair Average Quality (FAQ) standard for procurement of wheat, rice and paddy. These standards define the tolerance limits for the different quality parameters. Products having exceeded these limits are also procured by government agencies and are subject to a predetermined price penalty that is allowed up to a maximum limit (rejection limit), beyond which food grains are rejected.

The Prevention of Food Adulteration Act (1954) (PFA) has laid down standards for maximum limits of admixture of hazardous substances. This act also guards against adulteration of food grains with inferior quality. Some of the quality parameters like moisture content, foreign matter; damaged grains, etc. are also specified in both FAQ and PFA standards. While the permissible limits for common parameters are more precisely defined in FAQ standards, the PFA standards guard against the presence of hazardous substances, which are not covered by FAQ. In practice, a combination of both standards is followed for procurement.

In sum, rice should be in sound condition, sweet, dry, clean, wholesome, uniform in color and size of grains, and free from molds, weevils, obnoxious odors, admixtures of unwholesome poisonous substances, coloring agents and all impurities except to the extent permitted by such standards.

In international sales, rice is principally graded and priced on the basis of broken contents and degree of milling. This rice is generally highly polished. Technically, broken rice is not likely to be inferior in nutritive contents in comparison with whole rice. It is possible, however, that rice containing a higher proportion of broken grains will have a low storability and an unsatisfactory cooking quality. Appearance has considerable detrimental effects when the broken content of rice increases. Though rice containing

broken grains from 0 to 55 percent is marketed in India, usually, the broken contents range between 5 and 40 percent.

The degree of milling of rice for international trade is categorized as: under-milled, meaning the degree of milling is lower than 5 percent; medium-milled, meaning the degree of milling is in the range of 5-8 percent; and well-milled, meaning the degree of milling is higher than 8 percent.

Pakistan

Rice is one of the most important crops of Pakistan. It produces about 3 million tons of rice annually. Rice is recorded as the highest foreign exchange earner, contributing about 20% of the total foreign exchange of the country, and Pakistan ranks as the third biggest rice exporter in the world after Thailand and the USA. About 40% of the total production of rice is procured for export and the rest is consumed locally. The Government of Pakistan, through the Rice Export Corporation of Pakistan Ltd. (RECP) has completed an extensive quality assessment of exportable varieties of rice to maintain its reputation in the world market.

Inspection and grading at procurement centres

The Food Department officials inspect rice, in bulk, before issuing the disposal order for delivery to railheads. Food Inspectors posted at Procurement Centres are responsible for the inspection of rice lots tendered by the authorized dealers and if the rice is in accordance with the agreed specification, then it is accepted and dispatched by wagons and trucks to RECP's godowns located at Karachi.

Sampling and analysis

The objective of grain analysis is to accurately determine the quality of a sample. The Food Inspector of RECP carries out a spot analysis in the presence of representatives of authorized dealers. Ten grams of the composite sample are taken for the spot analysis.

The sample is spread out on a black tray and hand picking is done to separate all the refraction (quality factors) viz.: brokens, red, under-milled, chalky, foreign matters, paddy and other varieties etc. After analysis, the separated materials are weighed by physical balance and their percentages are calculated.

Super check on quality

The Government of Pakistan procures only quality rice so that the product can compete in the International Market and fetch premium prices. Thus, good quality standards are maintained for the procurement of rice by the Rice Export Corporation of Pakistan to achieve these objectives. Super Inspection Teams consisting of the Officers of the Food Department and the Rice Export Corporation of Pakistan undertake surprise visits and thoroughly inspect purchased stocks by analyzing the rice samples. The wagons dispatched from various parts of Punjab and Sind are again checked at Karachi by Super Inspection Teams to keep the procurement staff alert and vigilant in maintaining the quality of rice during the procurement season.

China

China ranks first in the world in paddy production. By application of government policy in agricultural production and marketing, the price of rice had been kept stable for the last 40 years. China has grain administration institutions down to the rural areas. These institutions control procurement, transportation, grading and storage, milling and supplying the finished products to the consumers. The grain administration developed multi-channel grain marketing and farmers are allowed to sell their surplus on the free market after fulfilling the government-levied quota.

There are four varieties of rice, Xian rice, Geng rice, Xian glutinous rice and Geng glutinous rice. The names of these varieties are based on the Indica and Japonica types. The Geng variety commands a higher price. Depending on the milling degree, they are classified into Super Grade, Grade 1, Grade 2, Grade 3, and Grade 4.

Rice Grading

(a) The species of rice:

There are four types of rice according to the species of paddy.

Species I:

Xian Rice: It is polished long-grained non-glutinous rice (Indica) that is long and oval or long and thin shape. It is divided into two varieties according to the grain and the harvest seasons:

Early Xian Rice: It has a bigger chalky portion at the ventral part and is of less hard texture.

Late Xian Rice: It has a smaller chalky ventral portion and is mostly of hard texture.

Species II:

Geng Rice: It is polished round-grained non-glutinous rice, which is oval shaped. It is divided into two varieties according to harvest seasons:

Early Geng Rice: It has a bigger chalky portion at the ventral part and is fewer in hard texture.

Late Geng Rice: It has a smaller chalky portion at the ventral part and is more in hard texture.

Species III:

Xian Glutinous Rice: It is polished long-grained glutinous rice which is long and oval or long and thin shape, opaque and waxy white colour and highly glutinous.

Species IV:

Geng Glutinous Rice: It is polished round-grained glutinous rice which is oval shaped, opaque and waxy white colour, and highly glutinous.

i. for all the species of rice, the total tolerance of mixing with other species of rice is 5%.
ii. The tolerance of yellow rice for all the species of rice is 2%.

(b) Quality standard

Depending on the milling degree, all the species of rice fall into four grades, which are, Super Grade, Grade 1, Grade 2, Grade 3 and Grade 4.

China utilises national grading standards in the exportation of rice to other countries.

Thailand

The rice standard of Thailand was established in 1957 by the Board of Trade, Ministry of Commerce, in order to control the quality of rice for exportation. The inspectors of the Board of Trade and some survey-agency members act as quality assessors. After rice samples are inspected, they are sent to the laboratory of the Board of Trade for certifying the quality and issuing necessary certifications. Every sample is analyzed for grain composition, grain classification, making allowances for admixture, degree of milling and moisture content. Grain samples are separated by hand and sieves. Grain classification is done by measurement of whole grain length. Admixture is ascertained by the quantity of contamination by red streaked kernel, chalky kernel, damaged kernel, yellow kernel, immature kernel, foreign matters etc. The degree of milling is determined by visual comparison of the rice sample as compared to a standard sample. There are four aspects of quality analysis for rice in Thailand. They are:

(i) grain quality analysis in breeding programmes
(ii) seed standard analysis in seed production programme
(iii) quality assessment of local paddy
(iv) quality inspection of rice for exportation.

It may be noted that the Government of Thailand has made it mandatory for all rice mills having a milling capacity of 25 tons per day and more to install a test mill and a moisture meter for quality evaluation. These methods of quality assessment greatly

facilitate grading, thus ensuing a fair price to the farmers. They grade paddy according to the export standards. Some big mills have already set up modern grain quality laboratories by using standard equipment to evaluate the quality and to determine the price of paddy.

Quality inspection of rice for export is the concern of the Board of Trade, Ministry of Commerce and Inspection Agencies. Rice samples are analyzed for grain composition, grain classification, allowance of the mixture, degree of milling and moisture content in accordance with the requirement of export rice standards established in 1957.

Malaysia

In Malaysia, procedures for paddy grading were reviewed in 1986. The project funded by the Government and the IDRC was being undertaken by the Malaysian Agricultural Research and Development Institute (MARDI) and the National Paddy and Rice Board (LPN).

The present grading system used by the National Paddy and Rice Board (LPN) is based on visual determination of grading factors such as immature grains, damaged grains, impurities and empty grains. A weight deduction system is used to compensate for the deficiencies in quality including moisture.

As regards moisture content, deductions are made on samples exceeding 14 percent moisture content and the rejection limit is at 25% moisture content. However, as LPN has to buy paddy with moisture content of more than 25%, a compromise has to be reached between the farmer and the LPN on weight deductions on account of high moisture content of procured paddy. Programs to improve the paddy grading system have been undertaken by the Malaysian Agriculture and Research Development Institute (MARDI) and the LPN. Studies on grading factors include the determination of potential milling yields, which will also reflect the standard of the white milled rice. Milled rice grading has been introduced and enforced since 1974 under the 'Price Control Act' by the

Government of Malaysia. Based on this act, all rice sold in Malaysia is classified into 16 grades. However, this system was reviewed in 1978 and short grain grades were deleted, as those varieties are no longer commercially produced.

Philippines

The Philippines completed a project in the 80's under the joint collaboration of the National Food Authority and the FAO. The report states that the system should ensure a better price for the growers based on the quality of paddy offered for sale. Similarly, the quality control personnel dealing directly with the farmers have gained necessary competence and skill in effectively carrying out the desired appraisal procedures.

Rice is the staple food of the Philippines contributing 74% of total food consumption. More than 30% of all agricultural land and more than 50% of the food cropland are devoted to rice. In 1986, the country produced 2.67 metric tons of paddy per hectare.

Under these accelerated production conditions, paddy and rice grading have become a major aspect in marketing both for local and international trade, quality assurance and in varietal improvement programs since the 70's. The National Food Authority is the agency entrusted with grain market stabilization, market development and industry regulation.

USA

In the United States all new rice cultivars are developed through intensive genetic selection of all important quality attributes. Selecting for desirable milling, cooking, eating and processing of hybrid selections, breeding lines in any new varieties of rice is an essential part of responsible rice breeding programs conducted by the U.S. Department of Agriculture (USDA) and the State Agricultural Experiment Stations in Arkansas, California, Louisiana, Mississippi and Texas. New varieties developed in these programs

must meet established standards for the milling, cooking, eating and processing qualities required of their particular grain type before they are released for commercial production.

Another major factor that influences rice quality is the environment under which the plant is grown. Once a new variety is released for commercial production it will be used wherever it can be produced advantageously in comparison with currently grown varieties. Consequently, before release, each new variety is extensively tested for quality in its likely production area. In the United States, tests are carried out in the Uniform Rice Performance Nurseries and other trials in each of the rice producing states. These trials provide the means for evaluating the quality characteristics of each new variety within environmental and modifying influences such as soil, climate and cultural conditions.

The factors affecting the grade of a particular lot of rice, including grain type, moisture, chalkiness and milling yields, are standardized by the USDA. Other equally significant factors involved in establishing rice grades include degree of milling, color, dockage (impurities) damaged kernels, red rice, odors, and seeds or kernels of any plant other than rice.

Table 1 — Definition of Technical Terms Used in Rice Grading: India, Pakistan and Bangladesh

INDIA	PAKISTAN	BANGLADESH
Long grain = 6.2 m.m.	Extra long grain = ≥ 7.00 mm. Long grain = ≥ 6.0 mm. - 6.9 mm. Medium grain = ≥ 5.0 mm. - 5.9 mm Short grain = ≤ 5.0 mm.	Extra long grain = > 7.00 mm. Long grain = 6.0 mm. - 6.99 mm. Medium grain = 5.0 mm. - 5.99 mm Short grain = ≤ 5.0 mm. Shape Length/Breadth Slender = >3.0 Medium = 2.4 - 3.0 Bold (Coarse) = 2.0-3.39 Round = < 2.0
Brokens = <2/3th of grain length Fragments = <1/4th of grain length	Head rice = ≥ 8/10th of grain length. Brokens = 3/4, 1/2, 1/4th of grain length, varying according to grades of rice Small brokens = ≤ 2/10th of grain length.	Head rice = ≥ 8/10th of grain length. Brokens = ≥1/2 th, of grain length Small brokens = ≤ 1/4th - <1/2th of grain length.
Chalky kernels = kernels that at least half of which are milky white in colour and brittle in nature.	Chalky kernels = kernels of which 50% or more of the surface area white like the colour of chalk.	Chalky kernels = Kernels, whole or broken, one half or more of the surface of which is white like the colour of chalk.
Damaged kernels = kernels, whole or brokens, that are internally damaged	Damaged kernels = kernels of which 25% or more are distinctly discoloured or damaged by heat, water, disease, insects or other means.	Damaged kernels = Kernels, whole or broken, which are distinctly damaged by insects, water, fungi or any other means which materially affect the quality of the grains.
Discoloured kernels = kernels, whole or broken, that are discoloured materially affecting the quality.	Yellow kernels = kernels of which 25% or more the surface area have turned yellow in colour.	Yellow kernels = kernels of which 25% or more the surface area have turned yellow in colour.
Foreign matter = include dust, stones, lumps of earth, chaff, stem or straw and any other impurity.	Foreign matter = all materials other than rice kernel, bran or paddy.	Foreign matter = all matter other than rice kernels, rice polishing and paddy.
Other rice = contrasting and/or inferior varieties of rice.	Green rice = kernels of green colour in Cargo (Brown) rice which when broken are also green in colour from inside or in the endosperm.	Green rice = Kernels, whole or broken, which are unripe and under developed.
Red kernels = kernels, whole or broken, which have 25% or more of their surface coated with red bran.	Shrivelled kernel = kernels which are spearlike in shape and whose widths are distinctly thinner than normal.	
** Dehusked grains = kernels, whole or broken, that have more than 1/4th of the surface of the area covered with the bran.	Red striped kernels = kernels of which 25% or more of the surface area are covered with outer red bran layer.	
Milling degree = Well milled, Reasonably well milled (varying according grades of rice)	Foreign grains = seeds other than rice such as wheat pulses, etc.	Foreign grains = Head rice and brokens other than the variety concerned.
	Undermilled rice = rice which is not equal to the milling requirements for "extra well milled," "well milled," "reasonably well milled" or "Ordinarily milled" as defined under Grades of Milled rice for milling degree	
	Milling degree = Extra well milled, well milled, reasonably well milled, ordinarily milled (varying according to grades of rice)	Milling degree = husked rice, undermilled rice, reasonably well milled, well milled, extra well milled.

** with specific method of checking

Table 2 — Comparison Rice Specifications: Philippines, Thailand, Vietnam and Pakistan

Specification	Philippines		Thailand		Vietnam		Pakistan	
	Grade 1	Grade 2	15% broken	25% broken	15% broken	25% broken	Grade 3 15-20% broken	Grade 4 20-25% broken
Whole kernels (min %)	NS	NS	55.00	40.00	50.00	50.00	} NS	} NS
Head rice (min %)	80.00	65.00	NS	NS	NS	NS	} 80-85	} 75-80
Broken (max %)	19.75	34.50	17.00	28.00	16.00	27.00	15-20	20-25
Small broken/chips/brewers (max %)	0.25	0.50	/1 1.00	/1 1.00	Nil	0.30	-	-
Damaged grains (max %)	0.25	0.50	1.00	1.00	/3 0.50	/3 2.50	} 4.0	} 5.0
Discoloured/yellow grains (max %)	2.00	4.00	1.00	1.00	1.00	1.00	}	}
Chalky grains (max %)	} 5.00	} 10.00	7.00	7.00	700	8.00	8.00	10.00
Immature grains (max %)	}	}	/2 0.40	/2 1.00	0	0.50	-	-
Undermilled grains (max %)	NS	NS	} 5.00	} 5.00	-	-	-	-
Red grains (max %)	0.25	0.50	}	}	} 2.00	} 5.00	-	-
Red streaked grains (max %)	3.00	5.00	}	}	}	}	3.50	4.00
Foreign matter (max %)	0.10	0.20	/2	/2	/4 0.20	/4 0.40	1.00	1.20
Paddy (max No./kg)	8	10	15	15	25	30	0.60%	0.80%
Moisture (max %)	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00
Milling degree	WM/RM	WE/RM	FWM	RWM	WM/RM	WM/RM	RWM	RWM
Size of brokens (Of Avg. Length of unbroken kernel)	<8/10th	<8/10th	<6.5/10th	<5/10th	<6.5th	<5/10th	<3/4th	<3/4th
Grade Equivalence	Slightly better than Thai 15%, Viet 15% and Pk 15-20%	Equivalent to Thai 25%, Viet 25%, and Pk 20-25%	⇩	⇔	⇩	⇔	⇩	⇔

Notes: NS =Not specified : WM = Well milled, RM = Regular milled; RWM = Reasonably well milled.
/1 = Inclusive in total brokens
/1 = Immature kernels, Undeveloped kernels, other seeds and foreign matter, either singly or combined are categorized together as one item.
/3 = Total immature + Damaged kernels, but tolerance for immature grains not exceeding the specified limit.
/4 = Of which the organic foreign matter is 0.02% max.
⇩= Slightly lower than Philippino Grade 1 ⇔ = Equivalent of Philippino grade 2

Table 3 — Rice Specifications: Bangladesh, India, Nepal and Pakistan

Specification	Bangladesh	India	Nepal	Pakistan
	Single parboiled	**Parboiled**	**Parboiled**	**IRRI parboiled**
Whole kernels (min %)	NS	NS	NS	NS
Head rice (min %)	NS	NS	NS	NS
Broken (max %)	8	15-17	16-20	14
Small broken/chips/brewers (max %)	2-4	NS	NS	1
Damaged grains (max %)	1	4	3-5	}1.5
Discoloured/yellow grains (max %)	1-1.5	8	4-8	}
Chalky grains (max %)	NS	NS	NS	3
Immature grains (max %)	1	NS	NS	NS
Undermilled grains (max %)	NS	NS	NS	}2
Red grains (max %)	NS	4	5-7	}
Red streaked grains (max %)	NS	NS	NS	NS
Foreign matter (max %)	0.3	0.5	0.5	}0.5
Paddy (max No./kg)	1	NS	NS	}
Moisture (max %)	14	14	14.5	14
Milling degree	Well milled	Well milled	Well milled	RWM
Size of brokens (Of Avg. Length of unbroken kernel)	<1/2th	<2/3th	NS	<3/4th
Grade Equivalence ⇩	Slightly better than India, Nepal and Pakistan	⇩	⇩	

NS =Not specified, WM = Well milled, RM = Regular milled; RWM = Reasonably well milled.
/1 = Inclusive in total brokens
/1 = Immature kernels, undeveloped kernels, other seeds and foreign matter, either singly or combined are categorized together as one item.
/3 = Total immature + Damaged kernels, but tolerance for immature grains not exceeding the specified limit.
/4 = Of which the organic foreign matter is 0.02% max.
⇩= Slightly lower than Bangladesh Grade

PARAMETERS OF QUALITY ASSESSMENT OF MILLED RICE IN BANGLADESH

Quality standards for milled rice depend on the following parameters:

Variety

There are innumerable varieties cultivated throughout the world which are grouped according to their morphological and physiological characteristics into three subspecies; *indica*, *japonica* and *javanica*. The *caryopsis* subspecies of the *indica* group is usually long, slender and rather flat with a length to width ratio of 3.1 to 3.5:1. The japonica varieties have a broad thick *caryopsis* with a length to width ratio of 1.4:1 to 2.9:1. The *javanica* varieties have short and wide *caryopsis* with the length almost equal to the width.

Classification of Bangladesh Rice According to Growing Season

The different rice crops are classified according to their distinct and different characteristics, which are summarized below.

Aus: These are period fixed photo insensitive varieties that mature in 80 to 120 days irrespective of sowing and planting time. Although they can be grown any time of the year the best yields are obtained when sown from March to May and harvested from June to August. The crops are badly infested by weeds and the quality is deteriorated due to the presence of weed seeds.

***Transplanted Aman*:** This is the main rice crop and is grown in large areas after the aus and jute crops are harvested. A large number of varieties belong to this group of rice. The grains are, in most cases, white and fine. Aman crop is harvested during November and December.

***Boro rice*:** This class of paddy is more or less similar to transplanted Aman as well as in methods of cultivation. Both red and white kernel rice varieties are found among this class of rice. Grains are generally coarse and are mostly awnless, but there are awned as well as awn-tipped varieties. They generally perform better than all the three classes of paddy stated above since they are grown during the period when the climate allows maximum photosynthesis. The varieties introduced from Japan and China, and particularly those from the IRRI that are cross-bred at the BRRI, are cultivated as Boro crop in Bangladesh with the highest yields among all rice varieties.

Aromatic: The aromatic varieties of rice are grown in 3 major regions of the country mostly in the Aman season. Like other common varieties there are innumerable aromatic varieties of rice being cultivated in the country. Farmers cultivate aromatic rice not only for home consumption for their special dishes, but also for commercial purposes. Despite the fact that non-aromatic rice varieties (mostly modern varieties) give significantly higher yields compared to aromatic varieties, the returns to aromatic varieties are much higher than that of coarse rice. Small quantities of aromatic rice are now exported mostly to cater to ethnic markets for overseas Bangladeshis.

Quality characteristics of rice

Rice quality is considered to have the following meanings:

(1) Physical quality, which determines presence of impurities and damaged kernels
(2) Milling quality, which refers to suitability of the grain for a particular end-use
(3) Cooking and processing qualities which refer to consumer acceptance and preference and also imply acceptable culinary quality
(4) Nutritional quality and all other aspects of rice quality

Presently, there are both objective and subjective methods of evaluation of rice quality. No practical objective method is available for determining odor, flavor, taste or

texture, for which, rice traders, processors and researchers must rely on their accumulated experience. Thus, only physical and milling qualities are assessed in any laboratory tests.

A PROPOSED PROCEDURE OF INSPECTION FOR GOVERNMENT PROCUREMENT

a) Before procurement, DGF inspectors should visit and inspect rice lots offered by authorised dealers/millers/ farmers to ensure agreed specifications, and to determine if the rice is acceptable for procurement.

b) Lots of rice brought by the dealers/farmers must be inspected again at the LSDs to confirm to the agreed specifications and to be accepted for storage.

c) Inspectors should record source, year, production season and designated variety (e.g. coarse fine and aromatic).

d) B-twill jute bags (Standard size & quality) should be inspected at the LSD sites to ensure their specifications.

e) Each bag containing supplied milled rice should be weighed. The standard bag weight should be 50 kgs net.

f) Upon inspection of the commodity, the inspector should record the date of inspection, grade and other necessary information on the lot and at the inspection book.

h) Sampling is to be carried out by the inspector of DGF from the lots. At least 5% of the bags should be sampled at random, as per standard sampling procedures and thus a representative sample from the lot is to be obtained. Samples drawn from different bags are to be thoroughly mixed on a smooth surface. Such samples are further divided into three sub-samples whose distribution is as follows:

i) Sample 1 is to be analysed on the spot.
ii) Sample 2 is to be delivered to the supplier.
iii) Sample 3 is to be delivered to the Technical Inspector at the district for final analysis.

i) Determination of grades.

- Collection of random samples from the lot.
- Sub-division of the sample to make working samples of 20 gm.

- Determination of moisture content by the moisture meter and correct the reading with the 105^0 C air oven drying method reading.
- Coloured grain, discoloured grain foreign grain (other varieties) and foreign matters are separated by hand and percentages are worked out.
- Chalky grain, damaged grain, and broken (big and small) grains are separated by hand.
- Determination of the degree of milling (well milled, under-milled) by visual inspection.
- Calculation of the thousand grain mass (TGM) of the sub-samples following the standard method.

FINDINGS FROM FIELD SURVEY

In order to collect relevant information on classification, grades and standards of milled rice, the LSDs of Rohanpur, Chapai Nawabganj, Mirzapur, Bogra, Golapbagh, Gaibandha, Akkelpur, Joypurhat, Pirganj, Thakurgaon, Monmothpur and Birol, Dinajpur district were visited. Information on rice storage, godown hygiene, quality parameters at procurement, storage procedures and inspection, disposal indicators, difficulties faced by the staff of LSDs during implementation, annual inspection of stock, in-service training of the staff were collected through a structured questionnaire.

In addition, rice quality information and samples were collected from the rice mills (Hullers and Auto Mills) of Sylhet, Chittagong, Mymensingh, Pabna, Naogaon, Chapai Nawabganj, Rajshahi and Dinajpur districts.

Collected samples were analysed in the Bangladesh Rice Research Institute (BRRI) Grain Quality Laboratory. After analysis, samples were grouped into four categories viz. Coarse, Medium, Fine and Aromatic varieties based on their **breadth**.

Coarse : Includes varieties whose breadth is more than 2.00 mm.

Medium : Includes varieties whose breadth ranges from 1.70 to 2.00 mm.

Fine : Includes varieties whose breadth is less than 1.70 mm.

Aromatic: Includes varieties possessing **aroma as an intrinsic quality.** The breadth of these varieties ranges from 1.55 to 1.74 mm.

Table 4 — Quality Analysis of Milled Rice Samples (Aman, Parboiled Coarse) Collected from Selected LSD's * DGF

Ac#	Variety	Moisture content %	Foreign matter (%)	Whole grains (%)	Head rice (%)	Brokens (%)	Small brokens/ brewers (%)	Yellow, dead and damaged (%)	Chalky and immature (%)	Paddy (%)	Other varieties (%)	Discolouration (%)
1.	Aman 2000	13.1	0.08	1.49	92.17	3.72	4.50	0.90	0.35	0	0.08	0.82
2.	Aman 2000	13.2	0.12	1.08	94.88	3.58	2.87	0.58	0.83	0	0.47	0.79
4.	Aman 2000	13.5	0.0	0.90	92.36	2.33	3.91	0.26	0.30	0	1.24	0.83
4.	Aman 2000	13.3	0.0	1.52	90.37	1.81	4.00	0.49	0.21	0	0.41	0.95
5.	Aman 2000	13.1	0	1.76	90.45	3.72	3.95	0.67	0.55	0	0.31	0.67
6.	Aman 2000	13.3	0	1.19	94.66	0.88	3.15	0.27	0.08	0.08	0.23	1.04
7.	Aman 2000	13.5	0	0.60	96.08	1.48	2.68	0.12	0.12	0	0	2.10
8.	Aman 2000	12.7	0	1.38	87.27	2.87	3.40	0.41	0.15	0.11	0.22	0.37
	Average	13.21	0.17	1.24	92.28	2.55	3.55	0.46	0.32	0.02	0.37	0.95

* LSD's of Rohonpur, Mirjapur, Akkelpur, Golapbag, Pirganj, Birol, Manmathpur.

Table 5 — Quality Analysis of Milled Rice Samples (Boro, Parboiled Coarse) Collected from Selected LSD's * DGF

Ac#	Variety	Moisture content %	Foreign matter (%)	Whole grains (%)	Head rice (%)	Brokens (%)	Small brokens/ brewers (%)	Yellow, dead and damaged (%)	Chalky and immature (%)	Paddy (%)	Other varieties (%)	Discolouration (%)
1.	Boro 2000	13.1	0.0	3.10	90.05	2.45	6.81	0.27	0.69	0	1.72	0.38
2.	Boro 2000	13.6	0.79	2.28	90.48	2.52	4.95	1.10	0.20	0	0.55	1.38
3.	Boro 2000	12.9	0.04	1.22	89.78	3.99	7.06	0.34	0.59	0	0.46	0.29
4.	Broo 2000	13.3	0.04	3.31	88.55	2.98	6.08	1.83	0.0	0.08	2.27	0
5.	Boro 2000	13.0	0.0	1.40	85.45	2.96	8.94	0.38	0.0	0	0.84	5.46
6.	Boro 2000	13.4	0	1.12	90.55	0.52	5.78	0.52	0.36	0	1.51	0.96
7.	Boro 2000	12.8	0.39	1.28	90.84	2.41	3.80	0.93	0.23	0	1.24	0.66
8.	Boro 2000	13.5	0.23	0.57	90.79	0.57	4.01	0.15	0.42	0	1.95	0
9.	Boro 2000	13.5	0	1.00	92.40	1.73	4.70	0.76	0.20	0	0.76	0.52
	Average	13.23	0.17	1.7	89.88	2.24	5.79	0.70	0.30	0.008	1.26	1.07

* LSD's of Rohonpur, Mirjapur, Akkelpur, Golapbag, Pirganj, Birol, Manmathpur.

** Note: Information on breadth of these rice samples is not available.

Table 6 — Quality Analysis of Milled Rice Samples Collected from Selected Rice Mills of Bangladesh (Parboiled-Coarse)

Ac#	Variety	Breadth (mm)	Moisture content %	Foreign matter (%)	Whole grains (%)	Head rice (%)	Brokens (%)	Small brokens/ brewers (%)	Yellow, dead and damaged (%)	Chalky and immature (%)	Paddy (%)	Other varieties (%)	Discolouration (%)	Underboiled
1.	BR11	2.17	13.0	0.33	89.38	90.33	6.04	3.71	0	.11	0	.44	1.78	
2.	BR11	2.17	12.3	0	89.21	89.69	4.52	4.55	0	1.35	0	0	0.42	
3.	IR-8	-	13.3	0.08	88.80	93.29	3.66	0.45	1.19	0.35	0	0.35	4.24	
	Average		12.87	0.14	89.13	91.10	4.74	2.90	0.40	0.60	0.0	0.26	2.15	

Table 7 — Quality of Milled Rice Samples (Parboiled-Medium) Collected from Rice Mills

Ac#	Variety	Breadth (mm)	Foreign matter (%)	Whole grains (%)	Head rice (%)	Brokens (%)	Small brokens/ brewers (%)	Yellow, dead and damaged (%)	Chalky and immature (%)	Paddy (%)	Other varieties (%)	Discolouration (%)
1.	Pajam	1.77	0	91.05	91.55	3.38	3.66	0	2.86	0	2.12	.40
2.	Sharna	-	0	93.63	94.35	1.99	1.13	0	.27	0	.24	.37
3.	Pajam	1.77	0	89.98	90.58	4.07	4.23	0	3.10	0	1.71	.20
4.	Sharna	-	0	93.56	94.03	3.08	2.03	0	.31	0	0	.39
5.	Mala (BR2)	1.90	0	83.03	85.73	7.41	6.32	0	5.74	0	3.90	8.28
6.	BRRI Dhan28	1.81	.03	94.14	95.13	3.17	2.49	0	.85	0	0	1.43
7	Sharna	-	.04	91	92.59	3.23	3.70	0	.79	0	0	1.59
8.	BR 16	2.00	.20	92.85	94.28	4.74	1.71	0	2.19	.15	1.61	5.01
	Average		0.03	91.16	92.28	3.88	3.16	0.0	2.01	0.02	1.20	2.21

Table 8 — Quality of Milled Rice Samples (Un-parboiled-Fine) Collected from Rice Mills

Ac#	Variety	Breadth (mm)	Foreign matter (%)	Whole grains (%)	Head rice (%)	Brokens (%)	Small brokens/ brewers (%)	Yellow, dead and damaged (%)	Chalky and immature (%)	Paddy (%)	Other varieties (%)	Discolouration (%)
1.	Chini atap	1.46	0.05	76.80	68.9	9.92	3.1	0	2.64	0	1.63	0
2.	Atop pajam	1.77	0.0	75.60	83.74	6.95	10.99	0	2.85	0	0.41	0.13
3.	Chini atop	1.46	0.0	76.01	81.15	10	10.30	0	1.11	0	4.45	0
	Average		0.02	76.14	77.93	8.96	8.13	0.0	2.2	0.0	2.16	0.04

Table 9 — Quality of Milled Rice Samples (Un-Parboiled-Aromatic) Collected from Rice Mills

Ac#	Variety	Breadth (mm)	Moisture content %	Foreign matter (%)	Whole grains (%)	Head rice (%)	Brokens (%)	Small brokens/ brewers (%)	Yellow, bead and damaged (%)	Chalky and immature (%)	Paddy (%)	Other varieties (%)	Discolouration (%)
1.	Chini Atap	1.46	12.8	0.05			9.92	3.1	0	2.64	0	1.63	0
2.	Chini Atap	1.46	12.6	0	76.01	81.15	10	10.30	0	1.11	0	4.45	0
3.	Kalijira	1.55	10.9	0	6.85	72.90	2.05	17.90	0	6.80	0	5.55	0
4.	Katharibhog	1.60	11.6	0	21.70	68.80	3.15	6.00	0	0.95	0	0.60	0
5.	BRRI Dhan34	1.60	11.9	0	26.07	59.28	13.72	3.33	0	0.78	0	1.52	0
	Average		11.96	0.01	26.13	56.43	7.77	8.13	0.0	2.46	0.0	2.75	0.0

* Collected during visits to the selected sites in Bangladesh.

Coarse variety

Moisture content of coarse Aman varieties ranged from 12.7% to 13.5 % with an average of 13.21%. Foreign matter is negligible. Big brokens ranged from 1.48% to 3.72% with an average of 2.55%. Small brokens ranged from 2.68% to 4.50% with an average of 3.55%. Other impurities such as chalky and immature grain; yellow, dead and damaged grain; other varieties; paddy; and red rice on an average are 0.32%, 0.46%, 0.37%, negligible and 0.95% respectively.

The moisture content of coarse Boro varieties ranged from 12.8% to 13.6% with an average of 13.23%. Big brokens ranged from 0.52% to 3.99% with an average of 2.24%. Small brokens ranged from 4.01% to 8.94% with an average of 5.79%. The presence of other varieties was 1.26% and red rice was 1.07%. Other parameters are similar to Aman varieties. Total brokens in Boro are higher (8.03%) than in Aman (6.1%). Red kernels and admixtures of other varieties are also higher in Boro than in Aman.

The actual parameters of big brokens, small brokens and other impurities in the coarse varieties of Bangladesh rice are much lower than in comparable varieties from India, Nepal, Myanmar, Pakistan and USA.

Medium variety

Big brokens in medium varieties ranged from 1.99% to 7.41% with an average of 3.88%. Small brokens ranged from 1.13% to 6.32% with an average of 3.16%. Other impurities such as chalky and immature grain; yellow, dead and damaged grain; other varieties; paddy; and red rice on an average are 2.01%, nil, 1.2%, negligible and 2.21% respectively. Foreign matter is negligible.

The parameters of big brokens, small brokens and other impurities in medium varieties of Bangladesh rice are much lower as compared to similar varieties from India, Nepal, Myanmar, Pakistan and the USA.

Fine variety

Big brokens in fine varieties ranged from 6.95% to 10.0% with an average of 8.96%. Small brokens ranged from 3.10% to 10.99% with an average of 8.13%. Other impurities such as chalky and immature grain, other varieties, and discoloured rice on an average are 2.20%, 2.16%, 0.04% respectively. Foreign matter is negligible.

The parameters of big brokens, small brokens and other impurities in fine varieties of Bangladesh rice are much lower as compared to similar varieties from India, Nepal, Myanmar, Pakistan and the USA.

Aromatic variety

Moisture contents in aromatic rice ranged from 10.9% to 12.6% with an average of 11.96%. Big brokens of non-parboiled aromatic milled rice ranged from 2.05% to 13.72% with an average of 7.77%. Small brokens ranged from 3.1% to 17.9% with an average of 8.13%. Impurities such as chalky and immature grains, other varieties and red rice kernels were 2.46%, 2.75% and nil. Foreign matters were found to be negligible.

Considering the quality parameters of Aromatic milled rice, it was found that total brokens are higher in Bangladesh (15.9%) as compared to Pakistan (12.5%). Other parameters including chalky and immature kernels, admixtures of other varieties, red rice kernels and foreign matters are much lower in Bangladesh aromatic rice as compared to Pakistani Basmati white rice. The Bangladesh major portions of the aromatic rice are produced for local consumption. As such, farmers give little attention to quality or grading. If export quality grades are specified, higher quality paddy can easily be

produced and, with improved milling, superior and high quality milled white aromatic rice can be produced to satisfy the international standard specifications.

Considering the actual quality parameters of Bangladeshi aromatic varieties of rice, it is proposed that *aromatic varieties of rice be classified as a separate grade for both domestic and international market.*

PROPOSED CLASSIFICATION OF MILLED RICE FOR DGF BASED ON "BREADTH"

Classification of rice varieties based on size and shape is universal. The majority of Bangladesh rice varieties is bold/coarse having a length of kernels below 6.00 mm. The breadth of different rice varieties varies distinctly from one other. In general, breadth and/or thickness are the indicators as to the type of grain: coarse, medium and fine. Intrinsic aroma is the determinant for aromatic varieties. Generally, the aromatic varieties have more slender kernels. Based on the foregoing discussions, four classes of Bangladesh rice are proposed: *coarse, medium, fine and aromatic. The varieties are classified by grain size, shape and breadth.*

Collected samples were analysed in the Bangladesh Rice Research Institute's (BRRI) Grain Quality Laboratory. After analysis, samples were grouped into four categories viz. Coarse, Medium, Fine and Aromatic varieties based on their **breadth**.

Coarse : Includes varieties whose breadth is more than 2.00 mm.
Medium : Includes varieties whose breadth ranges from 1.70 to 2.00 mm.
Fine : Includes varieties whose breadth is less than 1.70 mm.
Aromatic: Includes varieties possessing **aroma as an intrinsic quality.** The breadth of these varieties ranges from 1.55 to 1.74 mm.

PROPOSED GRADE OF PARBOILED COARSE MILLED RICE FOR INTERIM DGF PROCUREMENT

The following grades are proposed for the DGF for the interim period:

Table 10 — Proposed Grades for Parboiled (Coarse) Milled Rice

Quality parameter	Parboiled (Coarse) Milled rice	
	Boro	**Aman**
1. Moisture (max) %	14	13.5
2. Big broken (max) %	8.0	8.0
3. Small broken (max) %	3.0	4.0
4. Chalky & Immature kernel (max) %	Nil	nil
5. Admixture of other varieties (max) %	5.0	5.0
6. Yellow, dead, discoloured and damaged kernel (max) %	1.0	0.5
7. Paddy (per kg) no. (max)	1.0	1.0
8. Foreign matter (max) %	0.25	0.25
9. Red rice (max.) %	2.0	2.0
10. Milling degree	well milled	well milled.

Notes: Well milled means 10% polished grain.
The Directorate General of Food (DGF) procurement criteria has 12 quality parameters including moisture content, big broken, small broken, chalky kernel, admixture of other varieties, damaged grain, immature grain, discolored grain, paddy per kg, foreign matter, milling degree and under boiled. After analyzing the collected samples, the study group combined chalky and immature as one parameter; and dead, discoloured, damaged and yellow grain as another parameter. Therefore, the quality parameter of the proposed grades will be composed of 10 factors.

Table 11 — Proposed Grades of Milled Rice for Future DGF Procurement (Boro)

Quality Parameters	Parboiled			Aromatic
	Fine	**Medium**	**Coarse**	
Moisture (max.) %	14.0	14.0	14.0	14.0
Big brokens, (max.) %	4.0	4.0	5.0	12.0
Small broken, (max) %	3.0	3.0	3.0	4.0
Chalky & immature grain (max.) %	nil	nil	nil	nil
Admixture of varieties(max.) %	4.0	4.0	5.0	3.0
Damaged, dead, discoloured & yellow kernel (max.) %	1.0	1.0	1.0	2.0
Paddy per kg (max.) no.	1.0	1.0	nil	2.0
Foreign matter (max.)%	0.25	2.0	0.25	nil
Red rice (max.) %	2.0	2.0	2.0	nil
Milling degree %	Well milled	Well milled	Well milled	Well milled

Note: Well milled means 10% polished grain.

Table 12 — Proposed Grades of Milled Rice for Future DGF Procurement (Aman)

Quality Parameters	Parboiled			Aromatic
	Fine	Medium	Coarse	
Moisture (max.) %	13.5	13.5	13.5	13.5
Big brokens, (max.) %	4.0	4.0	5.0	12.0
Small broken, (max) %	3.0	3.0	3.0	4.0
Chalky & immature grain (max.) %	nil	nil	nil	nil
Admixture of varieties(max.) %	4.0	4.0	5.0	3.0
Damaged, dead, discoloured & yellow kernel (max.) %	1.0	1.0	1.0	2.0
Paddy per kg (max.) no.	1.0	1.0	nil	2.0
Foreign matter (max.)%	0.25	2.0	0.25	nil
Red rice (max.) %	2.0	2.0	2.0	nil
Milling degree %	Well milled	Well milled	Well milled	Well milled

Note: Well milled means 10% polished grain.

GENERAL OVERVIEW OF LABORATORY PROCEDURES

The complete physical analysis of samples shall be performed at the Regional Laboratory of the selected areas using the Standard Procedure. Figure 1 indicates a flowchart for milled-rice analysis procedures.

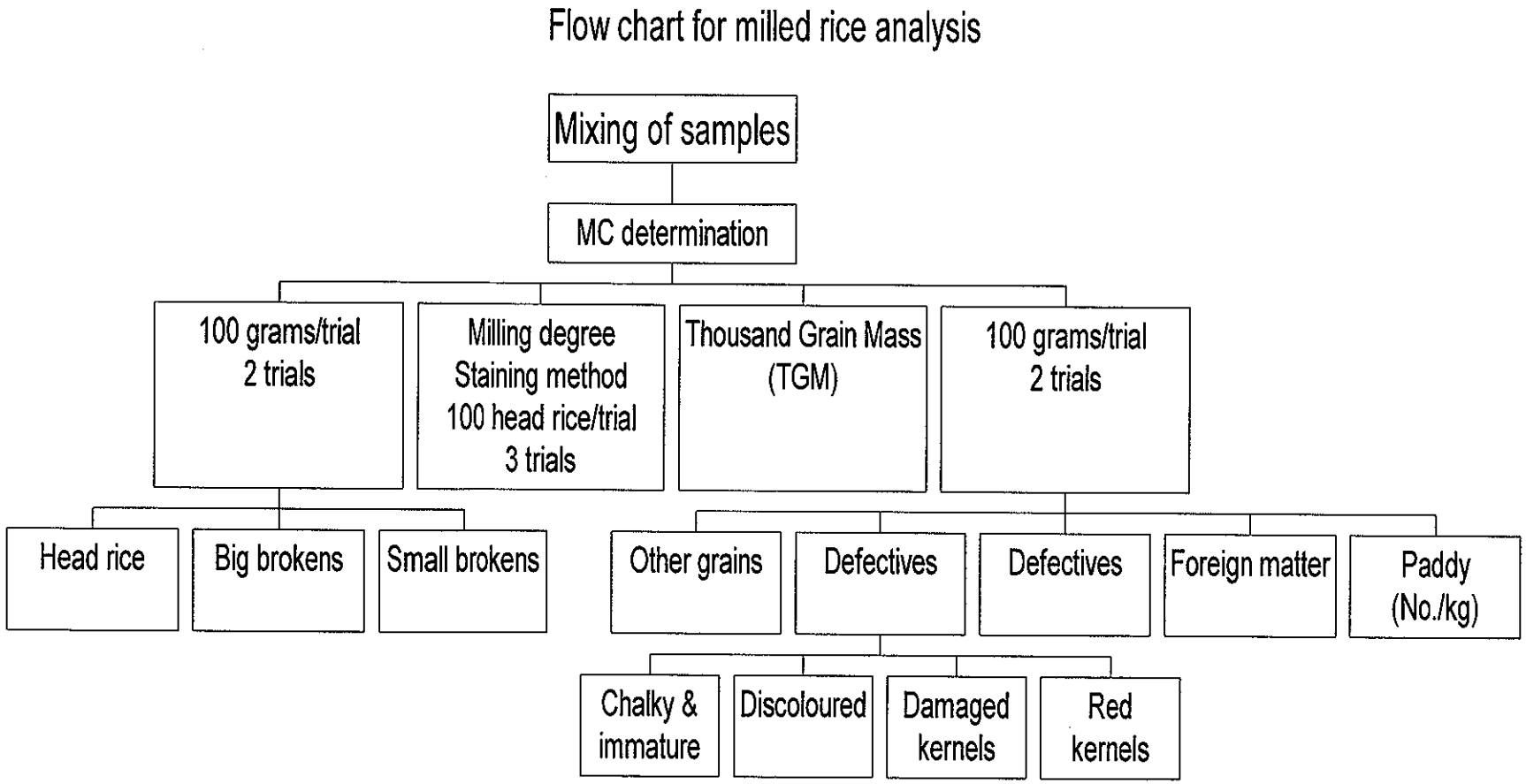
Physical characteristics such as head rice, broken grains, moisture content, defective grains and thousand grain mass (TGM) will be the basis for evaluating compliance to the national grains standards. Moisture content determination shall be done using a well-calibrated moisture tester.

Table 13 — Quality Standards for Milled Rice

Quality Parameters	Parboiled		Atap (Raw)		Aromatic
	Fine	Coarse	Fine	Coarse	
Moisture (Max.) %	13.5	13.5	13.5	13.5	13.5
Big brokens, (Max.) %	4.0	5.0	12.0	14.0	12.0
Small broken, (Max) %	3.0	3.0	4.0	4.0	4.0
Chalky and immature grain (Max.) %	nil	nil	1.0	2.0	nil
Admixture of varieties (Max.) %	1.0	2.0	1.0	2.0	3.0
Damaged, dead, discoloured and yellow kernels (Max.) %	1.0	1.0	2.0	3.0	2.0
Paddy (per kg) no. (Max.)	nil	nil	1.0	1.0	1.0
Foreign matter (Max.)%	0.25	0.25	1.0	2.0	nil
Red rice (max.) %	2.0	2.0	nil	nil	nil
Milling degree %	Well milled	Well milled	Well milled	Well milled	Well milled

Note: Well milled means 10% polished grain.

Figure 1


Flow chart for milled rice analysis
Mixing of samples
MC determination
100 grams/trial
2 trials
Milling degree
Staining method
100 head rice/trial
3 trials
Thousand Grain Mass
(TGM)
100 grams/trial
2 trials
Head rice
Big brokens
Small brokens
Other grains
Defectives
Defectives
Foreign matter
Paddy
(No./kg)
Chalky &
immature
Discoloured
Damaged
kernels
Red
kernels

CONCLUSIONS

In sum, classification, grades and standards of rice are of vital interest to the nation. It is a national imperative to introduce modern grades and standards for a multiple of reasons. They are important to the consumers, as cereal grains supply a large percentage of dietary calories for the people of Bangladesh. The government also procures large quantities of food grains from the internal market. Thus, it is a prerequisite that appropriate grades of food grains are procured so that they are fit for long storage and so that a wholesome and nutritious product is supplied to the people. These are preliminary efforts towards the end, when efficient and modern grades and standards of rice will be effectively introduced for the Ministry of Food, and the country. Grades and standards need continued revision and up-gradation as well as enforcement.

RECOMMENDATIONS

1. In order to provide improve the quality of milled rice in Bangladesh, a differential quality grading with an incremental pricing system needs to be formulated.
2. Standard quality criteria for paddy and milled rice needs to be enforced not only for government procurement but also for each level of paddy and milled rice marketing.
3. Based on the experiences of other neighbouring Asian countries, grading improvement of rice is not possible within a short period. Long-term programmes of 5-10 years are required. Efficiency of these programmes and consequent improvements in marketed products are to be measured on pre-determined indicators.
4. Appropriate rubber roll sheller machines should be introduced and installed at existing Engleberg rice huller mills for obtaining acceptable quality of rice and by-products. Installation of new Engleberg rice huller mills are to be discouraged and older ones modified or phased out. Black-ward linkage industries to produce rubber roll shelling machines and parts thereof, need to be developed to modernise this vital sector of the economy.

5. Paddy and milled rice grading improvement programmes are to be implemented through specialist groups on grading at district level. The Directorate of Food may take a leading role in this respect.
6. Procurement of rice and paddy may start progressively from the beginning of harvest time, as poor quality grains are marketed at the harvest time. The procured grains are to be kept in safe storage within a short time to avoid losses.

3. PROCUREMENT BY TENDERS

INTERNATIONAL TENDERS FOR RICE (1997-99)

Due to draught in 1997/98, and floods in 1998/99, Aman production was badly affected in the country. The estimated shortfalls in production were 1.1 million MT and 2.1 million MT respectively in rice production, which precluded the possibilities of internal procurement, as local market prices of rice moved beyond the Government's procurement price.

To maintain the Government stocks at a comfortable level, as well to service the needs of added distributions under various channels, the Ministry of Food decided to procure rice by both international and local tenders. It was assumed, and subsequently proved to be true, that the rice for local tenders will be supplied from imported sources, without putting any pressure on internal supply. In fact, domestic price levels were closely maintained at or very near the import parity prices during the months after post-flood Aman harvest till the arrival of Boro crops of 89-99. While the Government was augmenting public stocks by these methods, the private sector imported a total of 3.46 million metric tons of food grains in the 98-99 financial year.

In all, 8 local and 12 international tenders for rice and 5 international tenders for wheat were floated in FY 1997 to 1999. By this tender processes, the Government had procured a total of 0.432 million metric tons of rice and 0.584 million metric tons of wheat during this period. However, an evaluation and review of the past tenders may point to procedural and policy modifications to make this instrument more cost effective and efficient towards the Government's stated goals and objectives.

OBSERVATIONS ON TENDERS

1. International tenders for rice performed reasonably well in the FY 1997-98, though a member of time extensions were granted. The average time of delivery was 80 days for the period, though the contract stipulated a time of 30 days only in all cases.

2. Performance of the tenders deteriorated badly in the FY 1998-99 as only 62% of rice was delivered even after repeated extensions. The average delivery period extended to 109 days from the contractual delivery period of only 30 days.

3. Corrective measures like encashment of Performance Bank Guarantees (PBGs) did not improve the situation. Additionally, litigation and arbitration resulted, entailing further complications.

4. It may be noted that any price offered is also a function of time. Any variation of the period of supply makes the offered price non-effective for all practical purposes.

5. Grave difficulties with shipping are also being reported.

6. Difficulties with quality of rice shipped are also being reported.

Table 14 — Consolidated Statement for International Tenders for Procurement of Rice (1997–1999)

Sl. No.	Tender Date	Contracts Date with Quantities	Average Price per MT in US $	Date of Shipment as per contract and Last Date of Extension	B/L Qty MT	Last Dates of Vessel Arrival	Remarks
FY 1997/98							
1	15/01/98	Date: 24/02/98 50,000 MT No. of Suppliers 3 (three)	US $ 268.05	25/03/98 4 extensions allowed up to 20/05/98	47,907.15	Last Date of Arrival 14/05/98	Time Taken: 80 days Percentage of Supply: 96
2	24/02/98	Date: 31/03/98 50,000 MT No. of Suppliers 3 (three)	US $ 267.98	29/04/98 3 extensions allowed up to 25/06/98	51,599.97	11/07/98	Time Taken: 103 days Percentage of Supply: 103.2
3	Tender cancelled due to difficulties of extension of bid bond and the price quoted in the 4th tender was lower by about US $ 5.00 per metric tons						
4	12/04/98	Date:21/06/98 55,000 MT No. of Suppliers 2 (two)	US $ 260.98	20/07/98 2 extensions allowed up to 09/08/98	56,369.94	15/08/98	Time Taken: 56 days Percentage of Supply: 102.5
Sub-total A =		155,000	US $ 265.67		155,877.06		Avg. time of Supply: 80 days
FY 1998/99							
1	01/06/98	Date: 13/07/98 70,000 MT No. of Suppliers 4 (four)	US $ 249.89	11/08/98 3 extensions allowed up to 05/12/98	48,561.798	17/12/98	Time Taken: 158 days Percentage of Supply: 70
2	29/07/98	Date: 17/09/98 70,000 MT No. of Suppliers 3 (three)	US $ 252.74	16/10/98 3 extensions allowed up to 22/01/99 with penalty of 20% PG encashment	21,862.500	27/02/99	Time Taken: 164 days Percentage of Supply: 31 One vessel with 12000 MT was not delivered

Sl. No.	Tender Date	Contracts Date with Quantities	Average Price per MT in US $	Date of Shipment as per contract and Last Date of Extension	B/L Qty MT	Last Dates of Vessel Arrival	Remarks
3	25/08/98	Date: 18/10/98 75,000 MT No. of Suppliers 3 (three)	US $ 257.35	17/11/98 3 extensions allowed up to 15/02/99 with penalty of 20% PG encashment	52,495.225	07/03/99	Time Taken: 141 days Percentage of Supply: 70
4	29/09/98	Date: 25/11/98 1,00,000 MT No. of Suppliers 3 (three)	US $ 256.35	15/12/98 3 extensions allowed up to 25/03/99 with penalty of 20% PG encashment	97,517.332	19/04/99	Time Taken: 146 days Percentage of Supply: 60
Nill	12/11/98	Lowest bid offered in this tender was US $ 249.74/ MT					Cancelled
6	22/11/98	Date: 10/01/99 & 12/01/99 20,000 MT No. of Suppliers 2 (two)	US $ 255.83	11/02/99	17,625.000	17/03/99	Time Taken: 59 days Percentage of Supply: 20
* TCB	01/12/98 TCB	Date: 20/12/98 70,000 MT No. of Supplier 1 (one)	US $ 262.00	20,000 by Dec/98 50,000 by Jan/99	17,800.025	16/02/99	Time Taken: 59 days Percentage of Supply: 25
Nil	05/01/99	Contract Cancelled	US $ 256.58				Cancelled
8.	18-01-99	Date: 01-04-99 40,000 MT No. of Suppliers 4 (four)	US $ 256.49	01/05/99	19,949.775	09/05/99	Time Taken: 39 days Percentage of supply: 50
Sub-total B=		445,000	US $ 255.81		2,75,811.655		Avg. time of Supply: 109 Percentage of supply: 62
Grand Total = (A+B) (155,000+445,000)		600,000	US$260.74		4,31,688.715		Avg. time of Supply: 102 Percentage of supply: 72

Note: This purchase contract was on the basis of TCB's offer. However due to non-performance, part of PG has been en-cashed. The matter is now sub-judice as TCB has filed for injunction and applied for arbitration.

RECOMMENDATIONS

Alternative Sources of Supply

To avoid difficulties associated with a single source of supply, alternative source/s of reliable supply may be utilized. Unfortunately not many rice-exporting countries produce parboiled rice in quantities that are required for Bangladesh. India and Thailand are notable exceptions. In this respect, some difficulties were encountered in the differential specifications of MOF and Thai standard specification. However, an expert committee constituted by MOF, recommended Thai rice of 15% broken as the acceptable grade. A comparison with Thai 15% broken and MOF specification is attached to these papers for reference.

Table 15 — Comparison of Thai with MOF Specifications

Sl No.	Grades of Thai Specifications	Broken %		Dead, Damage and Discoloured Grains (DDD) %	
		Thai Specifications	MOF Specifications	Thai Specifications	MOF Specifications
1	100 % sorted	4		2.85	
2	100%	4		4.25	
3	5 % sorted	7		3.65	
4	5%	7		5.25	
5	10 % sorted	12	20% (maximum) (but	4.95	
6	10%	12	less than 1/4th broken	6.75	
7	15%	18	should not be more than	8.00	3% (maximum
8	25%	28	4%)	9.75	in total)

Table 16 — Grade of Thai Rice (BOT) Approved as Equivalent to MOF Specifications

Sl. No	Grades	Size of broken (Parts)	Broken %	Dead, Damaged and Discoloured Grains (DDD) %					Paddy (grain per 1 Kg)	Milling Degree
				Yellow kernel	Black kernel	Partly black and peck kernels	Dam-aged	Total		
1	2	3	4	5	6	7	8	9	10	11
7	15%	3.0-<6.5	18	2	0.5	4	1.5	8	10	Reason-ably well milled

Source: MOF Committee on Rice Specification dated 8-10-98

No Extensions

It appears that incentives exist for the suppliers to extend time of supply, as well as the 30 day delivery period, but this is unrealistic for practical reasons. Therefore, the time for delivery may stipulate for up to 60 days delivery time, with no allowable extension at all. This may be included in the tender terms to discourage the suppliers to request for time extensions.

Encashment of Performance Bank Guarantee

If any supplier fails to abide by the tender terms, action as per contract, including encashment of PBG, may be taken to discourage non-performing suppliers from further participation in tenders. Additionally, depending upon the performance, poor or non-performing suppliers may be de-barred from participating in future bids. Some difficulties were also encountered in en-cashing PBG from foreign banks. To avoid this difficulty, performance bank guarantees may be provided by banks located in Bangladesh. Alternatively, the Guarantee may also be provided by an acceptable negotiable instrument like Pay Order of Bank Draft in favour of the Ministry of Food, GOB.

Adoption of Commercial Norms

Acceptable and universally practiced commercial norms may be employed in execution of international tenders.

Special Measures for High Risk Contracts

If the market from which rice is procured is considered a high risk area, the following steps may adequately cover the risk of money, though they will not ensure supply:

- Performance Bond Guarantees of 5%, and 10% withholding of payment for post shipment payment (total 15% of contract value) may prove to be an insufficient security, where and when, losses/damages of higher percentages are likely. Thus, risks of poor quality of commodity, and other such risks are to be covered by additional instruments assuming that the risks may well exceed those 15% covered by PBG and partially withheld payments.

- Reputable shipping line/agency may be engaged to carry cargo, under liner terms or charter party contract, as desired.

- Post-shipment inspection may also be stipulated with additional clauses asking for additional guarantees to be inserted for this purpose in the contract. Required additional terms may also be included in the letters of credit, so that payments to the beneficiary are not made by the negotiating banks unless adequate surety has been ensured as to the quality and quantity of the cargo.

- In case of any inspection, either pre or post, 100% of cargo may be inspected and not a percentage check as normally practised.

- Adequate insurance policies to cover the risks may be taken out. This will vary from All Risks to only assessed risks, as the case may be. The government may determine the type of insurance policy that is to be taken considering the cost of insurance and the risk as assessed. In view of the performance of tenders from a high-risk market, it may well be wise to cover All Risk covered comprehensive insurance policies to safeguard public funds and accept higher premium costs as inescapable and unavoidable expenditures.

New Specifications

The specifications in these international tenders are considered by many experts as obsolete, and not used by any in rice exporting country. The government may formulate

modern and up-to-date specifications in conformity with international standards. In this respect, the government may consider forming an expert committee from within the Ministry with co-opted experts from such institutions as BSTI, BRRI, Agricultural University etc. to address this issue. These specifications will not only be useful in imports but are invaluable in the export of rice from Bangladesh, should the occasion arise any time in future.

Polybags

Stipulations of packing by B-Twill gunny bag only increase costs, with no demonstrable benefits to the government. This specification does not assist the Bangladesh Jute Industry at all; rather it assists the completing industries in other countries. A changeover to ploy bags will reduce costs of consignments. In one calculation, in Thailand, it was estimated that this packing material reduces costs by $ 4-5 per MT as compared to gunny packing.

LOCAL TENDERS FOR RICE (1997-99)

Background

Beginning in the aman season 1997/98, and ending in FY 98-99, in all, eight local tenders were floated for procurement of rice against payment by local currency. Total quantities of 344,000 MT of rice were contracted to be supplied. This was the first time that such large quantities of rice were tendered to be supplied locally by the MOF/DGF, although in the past, small quantities were procured by DGF by this method.

Advantages

Procurement by local tender has many important advantages as compared to other methods of procurement, namely:

1. Rice is procured at the market rate, rather than at the administratively determined fixed cost procurement, which to be effective, has to be above market rates. In this manner, substantial budgetary cost savings are achieved.

2. All the rice procured is to be delivered to the designated CSD's and LSD's, thereby:

- The grain is delivered at the points of distribution rather than at ports, saving substantial operational time.

- All costs include internal carriage and transit loss is built into the tendered prices. Therefore, these are the net prices of actual grain physically available at distribution points with no loss of goods. The Government does not incur any additional expenses on account of in-land transportation, transit loss or loss due to accidents.

- No grain remains in "transit," a percentage of which was written off in the past as a "loss."

- The Government pays only upon receipt of goods of the quality and quantity tendered for. There is no possibility of loss due to non-delivery, or losses due to shipping problems which are unfortunately always a probability in the case of procurement by international tender. Also, government monies are not tied up in letters of credit, as this system operates under a cash on delivery basis (COD).

- In addition, forfeited earnest money from the suppliers adds to the exchequer. As it will be seen, in the tenders under review, this amount was indeed a significant sum equivalent to 3694 MT of rice at the then prevailing prices.

Performance

The results of the tenders are as below:

1. Period of Review: FY 1997-98 and FY 1998-99

2. Number of Tenders: 8 (3 in 1997/98 5 in 1998/99)

3. Total Quantity Tendered: 503,000MT

4. Quantity Contracted: 344,000 (170,000 MT in 1997/98, 174,000 MT in 98/99)

5. Total Supply up-to-date : 147,444 MT

6. Average price per Kg: Tk. 13.684(13.37/Kg in 1997/98, Tk. 13.81/Kg in 1998/99)

7. Actual supply as percentage of contract qualities: 33% (57 in 1997/98, 10% in 1998/99).

8. Earnest Money forfeited from non-performing suppliers: Taka 50,453,753

Observations

1. The performances of internal tenders may be considered to be more or less satisfactory, especially in view of poor local Aman harvests due to devastating floods that precluded any significant internal procurement during this period.

2. In total, 147,000 MT of rice were procured by this method. Though this quantity is only 43% of contracted quantities, the average time of supply was 56 days. The delivery performance was improving, as the last two tenders were supplies only within 37 and 42 days respectively, indicating local suppliers were resolving many initial difficulties encountered by them.

3. The Government forfeited earnest money from non-performing bidders and thereby collected a significant amount (Tk 50,453,753).

Difficulties

1. Local suppliers based their offered prices on the import price of rice from India for these tenders. The most important reason for relatively poor performance is that the suppliers bid low prices. Apparently they misread the market signals and expected prices in India to move downward, whereas such downward price movements did not take place to any substantial degree in India. At the some time, transport costs in India moved upward putting them in further jeopardy. As traders gather experience with these tenders and develop trade networks and expertise, performance is likely to improve in the future.

2. Transportation problems, particularly shortage of railway wagons in India, put a bottleneck in movements up to border points. Technically, it is the responsibility of the suppliers to cover all risks, but a realistic appraisal will point to almost a force majeure situation in the January-February period due to railway transport problems in India. Because of the very low priced competitive bids by the tenderers, they could not utilise a higher cost road transport as other private sector importers did, as prices both in India and Bangladesh moved upward (fig-2).

Recommendations

1. Government may consider continued floatation of local tenders as long as the need to procure rice towards build up of required stocks exists.

2. Non-performing tenders may be cancelled and earnest monies forfeited to defray the administration costs of the Government. This step will also transmit appropriate signals to the suppliers, given in the language of money that is well understood in trading circles, that the Government means "business."

3. No time extension should be permitted, but a realistic time of supply of at least 8 weeks may be considered.

4. The size of the Earnest Monies/Performance Bank Guarantee (PBG) may be increased from 5 percent to 10 percent.

5. It is observed that most of the supply from India is effected by railway carriage. Therefore, the LSDs and CSDs aligning along the railways in the North South Axis in the Western Zone of the country are ideal points of supply. It is suggested that deliveries by local tenders may be concentrated along this axis. After deliveries, goods may be moved generally in an East-West direction by the normal movement procedure of the DGF to the desired locations in a planned manner.

6. Earnest money may be taken in the form of pay orders, which may immediately be cashed in an interest bearing account (as is practised by many Government Departments) and refunds may be given in fresh cheques. This procedure will earn some interest, which may be utilised at the discretion of the authorities.

CONCLUSIONS: PROCUREMENT BY TENDERS

As stated earlier, out of necessity, the Government has decided to purchase large quantities of food grains to help ensure the food security of the people. However, to efficiently procure food grains, by these methods, timing, quantity and quality issues are of paramount importance. It appears from the foregoing analyses that the international and local tenders for rice have not performed as well as expected, whereas procurement of wheat is satisfactory.

In view of the above, certain modifications of tender procedures have been suggested for consideration by the government towards solutions to problems of procurement by this method.

4. STORAGE ISSUES: CHEMICAL CHANGES IN FOOD GRAINS IN GOVERNMENT STORAGE

The history of storing food grains is as old as civilisation. Seasonal variations in harvest require storage of stock in excess of immediate requirements to adjust the mismatch between supply and demand. Grain quality can only be maintained over any period of time by proper storage. In Bangladesh, the main object of government storing food grains is to ensure a safe buffer stock of food grains in order to maintain food security at the national level. Food grains are also stocked by the government to service the needs of the Public Food Distribution System, and for programs of social security and disaster management.

STORAGE AT FARMER'S LEVEL

Farmers store food grains for their own consumption, as seeds, or for selling through commercial channels. At the farm level, storage is normally in the form of paddy, because paddy is less susceptible to deterioration in storage. The receptacles in use for storage vary in size and in the material used for construction. They may be temporary or semi-permanent but always built of cheap materials. Cylindrical bins made of unbaked clay are very common. Paddy, especially seed paddy, is stored in round bins made of straw and earth. The size of the bin may vary and depends on the need. This type of bin is normally leak proof and thus prevents entry of any moisture, insects or rodents. It preserves paddy for well over a year. A larger receptacle (5000-7000 kg capacity) may consist of a rectangular elevated structure of plaited bamboo build on piles and with a sloping thatched roof (*Gola*). Farmers also store rice in earthen bins (*Motka)* for short periods. In some cases, the mouth of the bin is sealed with mud and straw and will then preserve rice for extended period.

STORAGE AT MILLER'S LEVEL

The majority of rice mills store the paddy in *Kothas,* a battery of rooms built of brick and mud or mortar and provided with doors and a window. Paddy is stored over a 15 cm layer of paddy husk sprayed on the ground. In commercial storage, paddy is normally stored in jute bags, particularly when they are to be milled in the immediate future. Rice for commercial use is invariably stored in gunny bags in Bangladesh.

STORAGE AT THE GOVERNMENT LEVEL

Cereals are stored in the government LSDs, CSDs and SILOs for a period normally covering two cropping seasons. At present, there are 621 LSDs, 13 CSDs and four SILOs in the country, having a total installed capacity of storing of 15,66,850 MT. The godowns are constructed in almost every upazilla of the country. In CSDs and LSDs, cereals are packed in gunny bags and stored on wooden dunnage. There is no facility to control humidity and temperature in the godowns. In SILOs, wheat is normally stored in bulk condition. In some of these godowns, there are facilities to measure moisture levels of the stored grains. Arrangements are also available to spray insecticides and fumigate the stored grains to prevent the growth of microbes and to prevent and destroy insect pests.

STANDARDISATION OF DISPOSAL AND STORAGE INDICATORS

Standardization of disposal and storage indicators of various food grains are determined on the basis of quality and condition of the food grains. The government storage management procedures determine safe storage life of the grains by numbering. These numbers indicate period of safe storage of the grains so classified, and they must be disposed of within this time period. The grains are thus classified as DSD-1, DSD-2 and DSD-3, and so on. The numbers indicate months within which the grains must be disposed of before deterioration makes the grains unfit for human consumption, or total stock loss may occur.

CHEMICAL CHANGES IN FOOD GRAINS

Relevant literature based upon long accumulated experience indicates that chemical changes in food grains are a natural process and occur continuously resulting in the loss/gain of weight, change in physical appearance, loss of nutritional/food value, loss of culinary properties, and ultimately, total destruction of the grain. Stock deterioration is influenced mainly by post harvest processing and storage conditions. Conditions of storage, such as humidity, temperature, presence and attack of insects, rodents, fungus etc. determine to a large extent safe storage life of food grains. Of all the parameters of chemical changes, moisture is the most important factor. The process of the breakdown of triglycerides results in the production of free fatty acids and an increase in acid values. Breakdown of starch into smaller fractions results in the increase of reducing sugar that adds to the process of deterioration. Auto-oxidation of unsaturated fatty acids, producing peroxide and growth of fungus, has been recognized as the major parameters in changing the chemical composition of food grains. It may be noted that any change in protein occurs very slowly and thus may be ignored in any scientific study to find the determinants of chemical changes in grains.

OBJECTIVES OF THE STUDY

In Bangladesh, storing of cereal grains, especially rice, has a long history, though very few studies have been conducted on the chemical changes in the stored food grains. Understanding of the chemical changes in food grains in storage is vital for developing a viable storage strategy and procedures. While literature exists generally describing such changes in food grains in storage, no data or formula is available to storage managers for ascertaining and/or predicting food grains conditions in storage over long periods of storage. The Ministry of Food of the Government of Bangladesh, has therefore decided to conduct a study for ascertaining the chemical changes in food grains in government storage. The study will help the store managers to ascertain the quality of the stored food grains and act accordingly. The study has been designed to continue for a period of 5

months. This paper reports on the sampling techniques, physical condition of the godowns and the depots, and the chemical changes of grains sample drawn in the first round with a few preliminary observations.

STORAGE UNITS

The individual storage capacity of the sampled depots varies between 500 and more than 5000 MT. These units were selected under a sound statistical sampling scheme aimed to draw a representative sample lot of the entire government stock of food grains. Stock of food grains in these godowns, as on 30th June 2000, ranged between 25% to above 100% of the installed capacity, whereas 24 godowns have the installed storage capacity of 500MT, 1 has 750 MT and 5 have 1000MT. All the depots stored rice and wheat. Only 3 depots had oil and 9 had stored paddy. Twelve godowns stored food grains more than their installed capacity. Nine godowns stored 75-99%, 7 godowns stored 50-75% and 2 godowns stored 25-50% of their installed capacity. All the grains were harvested in the summer of 2000 in the *boro* season. The samples were taken within a period between 7 days to 6 months of the date of stock entry. But almost half the samples were taken within 3-5 months. Such a time gap between harvesting and stock entry into the food godowns was natural, given the cropping pattern and government procurement and subsequent movement of stock.

PHYSICAL CONDITION OF THE GODOWNS

All these storage units were constructed in a period starting in the early 1950s. Some of them were renovated and structurally modified during the intervening period that stretched to the 1990s. Most of the depots in the northwestern part of the country are located on flood free ground. The high flood level of 1988 did not affect any godown though some of them were only marginally saved. On physical inspection, six godowns had damp walls. The floors of nine godowns were in fair condition and those of five godowns were in poor condition. The ceilings of seven of the godowns were leaky. In

summary, the physical condition of five of the godowns was bad. The doors and ventilation systems of all the godowns were good.

CHANGES IN MOISTURE

Moisture content of the rice samples collected during the 1st round of sample collection ranged between 11.01 and 14.68% with the average of 13.73 ± 0.752%. Rice samples collected after 2 months of the 1st round and termed as 2nd round samples contained moisture between 12.53 and 14.49% with the average of 13.57 ± 0.528%. The 3rd round samples collected after two months of the 2nd round showed a moisture content of 11.35- 13.61% with an average of 12.30±0.570%. The 4th round samples collected after 1 month of the 3rd round samples contained moisture between 10.67 to 14.05% with an average of 12.27 ± 0.748%. It appears from the results that with the increase of the storage life, the rice moisture content decreases. Analysis of variance (ANOVA) of the results shows that the decrease in moisture content during the study period of 5 months is highly significant ($P<0.01\%$). But the change of the moisture content was not uniform throughout the entire storage period. Changes between the 1st and 2nd rounds and the 3rd and 4th rounds were not significant and the changes between and among all the other rounds were highly significant ($P<0.01\%$). It may be mentioned that 1st and 2nd round samples were drawn in November 2000 and January 2001 respectively, which is the winter season of the country. Relatively low temperatures and low humidity characterize the season. During the period, the maximum temperature ranged near the lower thirties and minimum temperature ranged around ten degrees centigrade or below. The humidity ranged 48 to 49%. As a result, the moisture content showed a tendency to decrease, but the decrease was not significant during November to January. Almost similar was the situation with 3rd and 4th samples drawn in March and April respectively. During this period the maximum temperature was 40^0 C and relative humidity ranged between 43-45%. As a result, the change in the moisture content was not significant during the period. The results obtained in this study agree with many previous investigations in these respects. It is noted that the study was conducted for a limited period of five

months covering a small range of change in relative humidity and temperature. However, the decrease in moisture content with the decrease in the relative humidity recorded during the study period was linear and highly significant ($P<0.02\%$). But with a higher relative humidity during the monsoon season, the nature of the curve is likely to change. A similar correlation may also be drawn with the change in moisture and the change in temperature as changes in temperature and relative humidity of the atmosphere are closely related. It may be noted that the rate of decrease of moisture content of the grains with age depends on a number of variables, such as initial moisture level, level of milling, physical condition and, ventilation facilities in the store, container, temperature, humidity etc. In Bangladesh government stores, there is no system to control these variables except a ventilation system near the ceiling. The doors constructed with wire-net fitted at the two ends of the godowns also allow air to enter into the godowns and come out by the other end. But during the night the doors remain closed for safety reasons.

One sample of imported wheat was collected from a local silo. The origin and age of the sample could not be ascertained. Results obtained with wheat also vary, similar to rice samples. No attempt, however, was made to correlate the results with those of rice samples.

CHANGES IN FAT CONTENT

Fat content of the rice samples drawn from various godowns during the entire study period has not changed significantly during the study period. Many investigators also reported similar results with polished rice and higher values for brown rice. Some authors also reported higher values. Fat content of the rice depends on the degree of milling, which removes the bran fraction from the grains. Most of the oil content in rice grains is found in rice bran, the removal of which improves the storability of milled rice.

CHANGES IN ACID VALUE

With the increase of storage life of the rice, the acid value showed a tendency to increase but this increase was not significant for the study period. Many past

investigators reported that acid value in rice grains did not increase up to 200 days of storage at normal temperature. But with the further increase of storage life and temperature, the acid value of rice grains increased. Some investigators reported different results. The difference in the results obtained in this study may be due to the differential experimental conditions, rather than any intrinsic quality of rice stored in government godowns.

CHANGES IN PEROXIDE VALUE

The peroxide value of fat extracted from the rice samples has increased with the increase of the storage life of the rice. But this increase was not significant. A number of investigators also reported similar findings and some of them reported higher values. The rate of increase of peroxide value depends on a number of factors such as post harvest processing, degree of milling, moisture content, temperature etc. The present study was conducted for only five months. From a comparison of the experimental condition and results reported by the other investigators, it appears that the increase in peroxide value that was observed during the study period was similar to that reported by the investigators. But the period covered in this study was not enough to produce comparable and conclusive results. Only a trend of the change can be reported here.

CHANGES IN REDUCING SUGAR

Reducing sugar content of the rice samples increased with age. But this increase was not significant. Many investigators in the past reported similar results. Normally freshly harvested rice contains higher amount of reducing sugar which decreases with age.

CHANGES IN FUNGUS LOAD

Fungus population in the food grains decreased significantly with the increase in age. But the degree of contamination was not uniform in the sampled bags in the godown, which resulted in the variation in the fungus population in various samples. This

may be due to the variation in the sources and degrees of contamination. Unhygienic handling during processing, milling and packaging might have contaminated the rice. Many investigators reported similar results. It is noted that the moisture content of the rice, humidity and atmospheric temperature in the godown might have exerted considerable influence on the growth of the fungal population. Investigators also reported that most of the fungus does not grow below 75% relative humidity and moisture content of rice below 14%. During most of the present study period, relative humidity was less than 75% and the moisture content of rice was less than 14%. As a result the fungal growth decreased.

CHEMICAL CHANGES IN WHEAT

One sample of imported wheat was collected from a local silo. The origin and age of the sample could not be ascertained. So, no attempt was made to correlate the results with those of rice samples. It may be noted that the results observed with wheat also show a similar pattern with those of rice.

CONCLUSIONS

The results obtained in the study showed that with the increase of storage life, the moisture content of the grains decreased significantly during the period of observation.

The effect of humidity was also significant. There was no significant change in fat content. Acid value and peroxide value showed a tendency to decease but the changes were not significant. The fungus population of the grains decreased significantly, which is attributable to the reduction of humidity during the study period. Reducing sugar did not change significantly. It may be noted that the period of observation covered five months during relatively low humidity and temperature climatic conditions. To fully understand these changes, grains in storage need to be exposed to the full range of climatic conditions in Bangladesh.

Table 17 — Chemical Changes Observed in Wheat

Parameters	1st Round	2nd Round	3rd Round	4th Round
Moisture	11.79	11.52	11.45	11.40
Fat	1.62	1.82	1.77	2.00
Acid Value	17.10	20.10	22.00	23.15
Peroxide	37.46	40.10	42.30	43.40
Reducing Sugar	0.243	0.238	0.232	0.383
Fungus	710	33	400	50

Table 18 — Summary of the Chemical Changes Observed in the Food Grains Stored in Government Godowns

Parameters	1st Round	2nd Round	3rd Round	4th Round	Comment
Moisture	13.73	13.53	12.30	12.27	HS (P<0.01%)
Fat	0.26	0.26	0.27	0.28	NS
Acid Value	6.36	6.64	6.73	6.81	NS
Peroxide	14.19	14.54	14.89	15.11	NS
Reducing Sugar	0.10	0.14	0.12	0.11	NS
Fungus	47042.9	1143.5	1296.25	12422.71	HS(P<0.01%)

HS = Highly Significant NS = Not Significant

However, it is safe to conclude that no significant chemical changes resulting in any major stock deterioration took place during the period under study covering November 2000 to April 2001 in the selected storage depots of DGF. Since these samples statistically represented the entire stock, it may also be assumed that the stock remained in good condition during the period under observation. From the parameters of chemical change it is also concluded that no significant deterioration of government stock took place during the period of observation.

5. PROSPECTS OF RICE EXPORTS

PRODUCTION POTENTIALS

Over the last three decades, the technology of the "Green Revolution" of High Yielding seeds, irrigation, fertilizer and pesticide enhanced rice production by mainly enhancing irrigated areas and yields. Yet, well over half of arable agricultural land remains non-irrigated, and yields are still much below their potential. Whereas per acre yield of rice in USA, Japan and South Korea are 6.4, 6.3 and 6.1 metric tons respectively, Bangladesh average yields are only 2.7 metric tons, indicating that rice production is yet to reach anywhere near its full potential. Increase of yield will not only enhance total availability of rice, but also release agricultural land for more high value cash crops like vegetables, cotton and potato. Such an increase in production will provide the surpluses needed for large scale export of coarse high-yielding varieties of rice to low-price specific markets.

FINE AND AROMATIC VARIETIES

Fineness in rice is a subjective quality as perceived by the consumers, though many national specifications, in Thailand for example, quantify the length and breadth of rice grains. The major aromatic rice varieties traded in the global markets include Basmati from North India and Pakistan and Jasmine from Thailand. Aromatic varieties are all traditional low- yielding types. The yield difference partly accounts for the higher prices of aromatic rice since farmers will require higher prices in order to offset lower yields.

AROMATIC AND SUPERFINE RICE OF BANGLADESH

The traditional aromatic varieties are grown only in Aman season. Surveys conducted by the Bangladesh Rice Research Institute in 1996 estimated total aromatic and

superfine rice production at 600,000 MT of paddy, equivalent to 300,000 MT of rice. The farmer level prices are hardly at a level to enhance production. Interviews with farmers indicated that if a price of about Tk. 900 to 1000 mound could be ensured, the production of aromatic rice can be enhanced many times. These rice varieties fetch premium prices in the international markets of EEC and USA at a great comparative advantage.

EXPORT POTENTIALS AND PROSPECTS

Most Asian countries produce rice for their own domestic consumption. Compared to other major grains, rice is thus thinly traded in the international market. Over the period of 1975–90, world production grew at a rate of 2.67% compared to a 2.57% growth achieved in export. Rice is not a homogenous commodity and a large number of types and varieties are traded in the international market. Mainly all rice traded in the international market is classified as long, medium and short. All rice is processed as white or raw rice or as parboiled rice. There is also specialty and aromatic rice, which are termed as gourmet rice in commerce. Thailand exports most of the rice as raw rice. However, a million tons of rice are exported after parboiling mainly to African countries by Thailand. Vietnam, the second largest exporter, exports almost all its rice as white milled. Indian exports are mainly of Basmati variety, though parboiled rice is exported to Bangladesh and many African countries. In the medium to long run, the volume of rice in the international market is likely to be enhanced with much higher prices than it is traded now.

Table 19 — Comparison of Boro Season Rice Price Volatility (Chittagong FOB As Compared to Bangkok FOB)

Month & Year	Chittagong FOB (US$/MT)	Seasonal Change (%)	Bangkok FOB (US$/MT)	Seasonal Change (%)	Price Comparison (%)
May-97	247	-9.3	297	-9.8	-20.2
Aug-97	224		268		-19.6
May-98	267	-3.4	299	2.0	-12.0
Aug-98	258		305		-18.2
May-99	219	0.5	229	3.5	-4.6
Aug-99	220		237		-7.7
May-00	206	-5.8	168	4.2	18.4
Aug-00	194		175		9.8

Source: USDA, DAM

Note: Grades for Rice are as follows:

1. Bangladesh Rice = HYV Coarse
2. Bangkok = Thai 15% Parboiled

Standardization of grades leads to improvements in production and marketing, and thus enhances efficiency. For the development of export it is absolutely essential that they conform to international standards. It is suggested that a committee of experts grade the rice produced in Bangladesh as per international standards. These export grades are essential to quote prices and to receive export inquiries, large number varieties of aromatic rice are also produced in Bangladesh, varying from small, to long slender types. Demand for aromatic and specialty rice is growing in the international market. Major international buyers of Aromatic rice are China, Middle East, E.U. countries, and the United States. The international market for aromatic rice is growing very rapidly. From 1990 to 1996 the international traded quantities of aromatic rice has increased from 1.4 to 2.4 million MT. The production of aromatic rice cannot be increased rapidly because the varieties rarely reproduce their characteristics in other climatic and soil condition. In total, exports of aromatic rice ranged roughly from 2.0 to 2.5 million MTs or about 12-15% of the world exports. Bangladesh prospects to produce and export these high value varieties is high, but lack of infrastructure like storage, standard packaging machinery and

high cost of shipping, and trade barriers by some importing countries are hampering their production and export. All traditional and aromatic varieties in Bangladesh are grown without chemical fertilizers. It is, therefore, a matter of organization and effort that organic rice may be grown and exported from Bangladesh.

MECHANICS OF EXPORT

Excellent prospects exist for export of medium grain, special aromatic and organic rice from Bangladesh. Export parity prices of both traditional and HYV varieties of rice are below the comparable grades of Thai rice at much of the harvest seasons of both Aman and Boro. As compared to Indian coarse rice FOB prices, it is very rare that our rice of any grade is competitive, though occasionally our FOB prices do go below the Indian FOB prices. But lower prices do not automatically ensure export. Many other considerations like grades; milling standards, packaging and reliability of the suppliers are the major factors influencing major exports of rice in the international markets. Bangladesh's own rules, laws and regulations regarding the rice industry were formulated mostly in colonial times of war and chronic shortages, and need to be reviewed and changed in order to export rice in an era of surplus.

CONCLUSIONS AND RECOMMENDATIONS FOR RICE EXPORTS

The phenomenal rise in rice production by the way of irrigation, fertilizer production and distribution, agricultural research and extension is an outcome of national aspirations and consequent governmental food policies. As Bangladesh achieves surpluses in rice production, efforts to export rice of many varieties that Bangladesh produces may be considered as a deliberate policy. There are many rationales regarding rice-exports. The enhanced production of special, aromatic and organic rice offers the best comparative advantage in this regard. An excellent market exists for moderate quantities of these extremely high-priced rice varieties in the international market. It is also possible to export medium to coarse parboiled rice especially to African markets where demand for such rice is currently satisfied by imports from Thailand and India.

Higher production means benefits to the producer and the consumers by lower prices, which should not be below export parity price. To successfully export rice, however, much more is necessary than just theoretical low prices and notional surpluses.

By taking recourse to a trade based stabilization policy of import in times of shortages, and export at times of high production, rice prices may be kept within a narrow band of import-export parity price as an instrument of price stabilization. Export of rice will enhance food security for the poor, and will not diminish by enhanced importation of cheaper but more nutritious grains such as wheat. This importation will be balanced against monies earned by the export of fine quality rice at a great comparative advantage. But to export rice on any significant scale, a conducive policy package need be implemented.

Thus, it is recommended that:

- All out dated and restrictive laws and regulations inhibiting free trade in rice by the private sector be rescinded to create an enabling environment.
- Encourage investments to upgrade mill-machinery, storage and other essential infrastructure for a modernised rice industry in the country, to produce high quality rice.
- Provide adequate credit within the existing banking regulations to the traders, millers and exporters of rice, in conformity with other export commodities.
- Establish a centralised agency, preferably at the Ministry of Food, like the now-defunct Export Cell, to co-ordinate, promote, encourage and assist export efforts of rice by private sector firms.
- Take effective steps to remove import levies in importing countries in European Union.
- Upgrade national grade and standards of rice, especially for exports, and disseminate and enforce the same in the market place.
- Improve markets and their structures and especially consider establishing a central market where traders, whole-sellers and exporters may transact business freely.
- Invest in infrastructure like port handling facilities; improve financial and other risk management services like insurance, banking and inspection agencies to facilitate exports.

At the same time, the current policies of production enhancement are to be pursued with a renewed vigor. Those policies are namely:

- Investments in agricultural research and extension services

- Continuance and improvements of liberalised market for seeds, chemical fertilisers, agricultural machinery, pesticides and other essential inputs of agricultural production.
- Development of aromatic, superfine, organic and other high-value speciality rice varieties and their commercial production at farmer's levels.

With the opening of the Bangabandhu Jamuna Bridge, rice from the surplus Northern districts may speedily and economically move to Chittagong port for export. A new era of surpluses is envisioned, when export, and not import, of rice will be the major concern for Bangladesh. It is time to plan, prepare and exert efforts towards that direction. Newer and changed governmental policies and private sector participation are needed to exploit the full potentials of production in the country, and exploit international market demands of rice from Bangladesh.

6. CONCLUSIONS

The foregoing pages almost exclusively address the issues in relation to technical aspects of food policy implementation. The issues are varied in implication, as they attract considerations across a multi-disciplinary arena, and demand in-depth research in many fields. Thus, for example, purely scientific studies regarding grain chemistry and physiology of stored grains must be co-related with planning, management, financial and handling procedures to devise effective instruments of policy implementation. It may be noted that a policy is only as good, or, as effective as the extent of its implementation. Implementation is effected by means of adequate instruments to do the job. Rules and procedures are then placed in order to efficiently utilize these varied policy implementation instruments towards achieving the desired policy goals.

This synthesis paper abstracts research findings covering many unrelated matters but they all converge to address policy implementation issues. Thus, they concern themselves with finding answers to many practical questions that arise over food policy issues. As such, specific recommendations based upon research findings have been made regarding improved grades and standards of rice, procedures of procurement by competitive tenders; chemical changes in food grains in government storage and possibilities of export of various grades of rice from Bangladesh. These remain as inputs in policy implementation process. The dynamics of changing scenarios affecting the entire gamut of national food policy attract in-depth analysis and findings as inputs to formulate effective and timely implementation procedures. These, in turn, demand more effective instruments that are to be applied for new policy implementation. It is hoped that these findings and recommendations will assist the policy implementers by a better understanding of the complex factors and parameters concerning these matters. The government, after due deliberations, may evolve more cost-effective, efficient, and

modern rules and procedures by considerations given to many other factors that remain outside the purview of these papers.

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