Economic and Social Commission for Asia and the Pacific

CAPSA WORKING PAPER No. 80

Enhancing Sustainable Development of Diverse Agriculture in Bangladesh

Jahangir Alam

United Nations
ESCAP

UNESCAP-CAPSA

The Centre for Alleviation of Poverty through Secondary Crops' Development in Asia and the Pacific (CAPSA) is a subsidiary body of UNESCAP. It was established as the Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (CGPRT Centre) in 1981 and was renamed CAPSA in 2004.

Objectives

CAPSA promotes a more supportive policy environment in member countries to enhance the living conditions of rural poor populations in disadvantaged areas, particularly those who rely on secondary crop agriculture for their livelihood, and to promote research and development related to agriculture to alleviate poverty in the Asian and Pacific region

Functions

1. Coordination of socio-economic and policy research on secondary crops.
2. Networking and partnership with other international organizations and key stakeholders.
3. Research and analysis of trends and opportunities with regard to improving the economic status of rural populations.
4. Production, packaging and dissemination of information and successful practices on poverty reduction.
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Enhancing Sustainable Development of Diverse Agriculture in Bangladesh

"UNESCAP-CAPSA: Centre for Alleviation of Poverty through Secondary Crops' Development in Asia and the Pacific"

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through Secondary Crops' Development
in Asia and the Pacific

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List of Abbreviations

Organizations

BADC	:	Bangladesh Agricultural Development Corporation
BARC	:	Bangladesh Agricultural Research Council
BARI	:	Bangladesh Agricultural Research Institute
BRAC	:	Bangladesh Rural Advancement Committee
CAPSA	:	Centre for Alleviation of Poverty through Secondary Crops' Development in Asia and the Pacific
CGPRT	:	Coarse grains, pulses, roots and tubers
EEC	:	European Economic Community
ESCAP	:	Economic and Social Commission for Asia and the Pacific
EU	:	European Union
MOA	:	Ministry of Agriculture
NGOs	:	Non-Government Organizations
OECD	:	Organization for Economic Cooperation and Development

Measures

CPI	:	Consumer Price Index
DRC	:	Domestic Resource Cost
EPC	:	Effective Protection Co-efficient
ERP	:	Effective Rate of Protection
Kcal	:	Kilo Calorie
kg	:	Kilogram
NPC	:	Nominal Protection Co-efficient
NRP	:	Nominal Rate of Protection
SID	:	Simpson Index of Diversity
SP	:	Specialization Index

Commerce and Trade

c.i.f.	:	Cost, Insurance and Freight
f.o.b.	:	Free on Board
GATT	:	General Agreement on Tariffs and Trade
URAoA	:	Uruguay Round Agreement on Agriculture
AMS	:	Aggregate Measure of Support
HYV	:	High Yielding Variety
HIES	:	Household Income and Expenditure Survey
PSE	:	Producer Subsidy Equivalent
PRSP	:	Poverty Reduction Strategy Paper
RNF	:	Rural Non-Farm
Shogorip	:	Shosha Godam Rin Prokalpa (Crop Storage Credit Project)
VAT	:	Value Added Tax

Local Terms

Cheena	:	Proso millet (*Penicum miliceum L.*)
Gur	:	Molasses
Kaon	:	Foxtail millet (*Citera italica*)
Lakh	:	One Lakh = One hundred thousand
Taka	:	Bangladeshi Currency (Taka 69 = 1 US dollar, approximately) in 2004
Upazela	:	Sub-district

Foreword

Most Asian countries succeeded in multiplying major cereal production through the green revolution. This was made possible by the introduction of high yielding varieties and policy support which promoted the construction of irrigation facilities and the use of modern inputs such as chemical fertilizers and pesticides. However, recently the growth in productivity of major cereals has reached a plateau. Agricultural diversification has a number of positive effects, among others, food security, risk mitigation, labour absorption and conservation of biodiversity. It is crucial to be aware of the driving forces and constraints to agricultural diversification to formulate policy options which realize the coexistence of sustainable agricultural development and poverty reduction in rural areas.

Responding to this vital need, UNESCAP-CAPSA conducted a three-year research project, "Identification of Pulling Factors for Enhancing Sustainable Development of Diverse Agriculture in Selected Asian Countries (AGRIDIV)", from April 2003, in collaboration with eight participating countries, namely Bangladesh, India, Indonesia, Lao People's Democratic Republic, Myanmar, Sri Lanka, Thailand and Viet Nam.

It is my pleasure to publish "**Enhancing Sustainable Development of Diverse Agriculture in Bangladesh**" as a result of the first phase of the Bangladesh country study of the project. This volume presents a descriptive and quantitative analysis of the current secondary crop agriculture and development constraints and options. This study focuses on policy recommendations, as well as areas of/for farther study.

I thank Dr. Jahangir Alam for their efforts. Continuous support from the Bangladesh Agricultural Research Council (BARC), is highly appreciated. Prof. Hitoshi Yonekura, Graduate School of Agricultural Science, Tohoku University, Mr. Tomohide Sugino and Dr. Parulian Hutagaol provided useful guidance at every stage of the study as regional advisor, project leader and associate project leader respectively. I extend thanks to Mr. Matthew Burrows for his English editing.

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April 2005

J.W. Taco Bottema
Director
UNESCAP-CAPSA

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Many academicians and researchers made significant contributions in conducting this study. Among them, I note a deep sense of gratitude to Mr. Tanvir Mahmud Bin Hossain and Mr. Md. Sayedur Rahman, Scientific Officers, Agricultural Economics Division, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur, Mr. Fakir Azmal Huda, Assistant Professor, Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh, Mr. Mohammed Ismail Khan, Lecturer, Department of Agricultural Economics, Bangabandhu Sheik Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur, Dr. Kazi Mesbahul Alam, Principal Scientific Officer, Agricultural Economics Division, BARI, Dr. S.M. Fakhrul Islam, Associate Professor, Department of Agricultural Economics, BSMRAU and Dr. Md. Abdul Quayyum, Principal Scientific Officer, On-Farm Research Division, BARI for collection, supervision and analysis of data for this study. Other members of the study team, namely Mr. Nazrul Islam, Senior Scientific Officer, Agricultural Economics Division, BARI, Ms. Fatema Wadud, Deputy Director, Shoshaya Godam Rin Prokalpa, Directorate of Agricultural Marketing (DAM), Dhaka, Mr. Naser Farid, Deputy Chief, FPMU, Ministry of Food, Dhaka, Mr. Md. Fozlul Haque, Deputy Director (Monitoring), Directorate of Agricultural Extension (DAE), Dhaka, Mr. Ershadullah Khan, Deputy General Manager (Research), Bangladesh Bank, Dhaka, Mr. Md. Abdullah, Deputy General Manager (Statistics), Bangladesh Bank and Dr. S.M. Elias, Former Director General, Bangladesh Jute Research Institute (BJRI), Dhaka attended meetings and provided information, guidance and comments. I am grateful to all of them.

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I am particularly grateful to Mr. Tomohide Sugino, AGRIDIV Project Leader, UNESCAP-CAPSA, Indonesia and Professor H. Yonekura, Tohoko University, Japan for supervising the study.

Above all, I must record my sincere gratitude to Dr. M. Nurul Alam, Executive Chairman, Bangladesh Agricultural Research Council (BARC), for allowing me to conduct this study.

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Executive Summary

Agriculture is the most important sector of the economy of Bangladesh contributing about 23 per cent of the country's GDP and employing about 62 per cent of the country's total labour force. The agricultural sector is composed of crop, livestock, fisheries and forestry sub-sectors. The crop sub-sector dominates the agricultural sector accounting for 57 per cent of agricultural GDP. Main crops of the country include rice, wheat, pulses, oilseeds, sugarcane, potato, vegetables, jute and tea. Rice is the staple food of the country, which is grown on over 74 per cent of the total cropped area.

Bangladesh has been a food deficit country for several decades. Therefore, emphasis was given to rice and wheat production for achieving self-sufficiency in food grains in the country. During the green revolution in the 1970s and since, the government promoted rice and wheat production through the adoption of new seed-fertilizer-irrigation technology. As a result, some secondary crops including coarse grains (CG), pulses (P), roots and tubers (RT) (CGPRT), which occupy about 6 per cent of total cropped area became less attractive. These crops in less favoured environments were largely untouched by the growth process. Some of these crops, for example pulses and tubers, exhibited a declining trend. The country became more dependent on imports of maize and pulses. It was, therefore, necessary to examine possibilities of import substitution and export promotion through diversification of crop agriculture. It was also necessary to find ways to shift from rice monoculture to diverse agriculture through increased production of CGPRT crops. This diversification is required to improve soil health, increase productivity, ensure food security, mitigate risk and protect the environment. This would also increase employment opportunities and income of the poor people in Bangladesh.

A study was undertaken in 2003 to examine possibilities of enhancing the sustainable development of diverse agriculture in Bangladesh. The study was sponsored by UNESCAP-CAPSA and was implemented by the author under a MOU between ESCAP and BARC. Specific objectives of the study were as follows:

- To investigate the current status of CGPRT crops in terms of area, production, yield, consumption and marketing.
- To determine the magnitude of agricultural diversification and analyze the existing policies of the Government of Bangladesh in relation to diversification.
- To determine the profitability and comparative advantage of producing CGPRT crops.
- To calculate marketing costs and margins of products of CGPRT crops.
- To analyze the impact of recent economic reforms and trade liberalization on upland CGPRT crops.
- To explore the potentials of alleviating poverty through the development of CGPRT crops.
- To assess the demand for CGPRT crops and explore the potentials to meet the changing demand.
- To investigate the nutritional and /or industrial importance of CGPRT crops as well as diversified ways of consuming them and to explore the potential of product diversification to meet changes in demand.
- To examine constraints to and prospects of crop diversification with CGPRT crops.
- To recommend policies for enhancing the production and consumption of CGPRT crops in Bangladesh and elsewhere in the region.

An attempt was made to collect and analyze both primary and secondary data to fulfill the objectives of the study. Secondary data available in various statistical bulletins, reports and official records was assembled and primary data was collected from the field to complement the secondary data. An analysis of historical data collected from secondary sources was made to determine the effect of policy changes on production and diversification of secondary (CGPRT) crops. At the same time primary data was made available from the field surveys to inform about the recent structure of incentives in agriculture. The study collected primary data from 400 samples selected randomly from 12 districts of the country representing the concentrated areas for CGPRT crops. Data so collected was analyzed to determine financial and economic profitability of producing CGPRT crops in Bangladesh. A measure of comparative advantage was employed to examine the efficiency of using resources for producing CGPRT crop products at home instead of importing them from abroad. To evaluate quantitatively the diversity of crop production, a diversity index was used. The future demand for CGPRT crop products was determined by using an anticipated population growth rate, growth rate of income and income elasticity of demand for these crop products. The income elasticity of demand was computed from cross-section consumption figures obtained through the HIES 2000.

Analysis of data shows that there has been a significant increase in agricultural production in Bangladesh over the last four decades. The production of food grains increased from 9.7 million tons in 1960-1961 to 10 million tons in 1972-1973 and to about 27 million tons in 2002-2003. The production of rice has increased by about 3.5 per cent per year over the last decade. The production of wheat has experienced a significant increase of 5.5 per cent per year over the same period. But the production of minor grains declined by 0.93 per cent, pulses by 3.72 per cent, oil seeds by 1.9 per cent, and sweet potato by 2.8 per cent over the same period. However, the production of maize and potato have experienced a respectable growth rate during the last decade. Moreover, production of vegetables and spices have also shown an increasing trend over that period. The calculated Simpson Index of diversity for the allocation of land to different crops revealed a slow improvement of crop diversification over time in Bangladesh.

The improvement in diverse crop production was accompanied by considerable diversification in consumption. The share of rice and wheat in the total food basket has declined, while the share of potato, vegetables and pulses has increased over the reference period. This may lead to further diversification of crop agriculture in future if there are enough incentives to cultivate minor grains and non-cereal crops.

A field study conducted in 12 districts on maize, millets, potato, sweet potato, lentil and mungbean suggests that both financial and economic returns to production of those secondary crops are positive. The financial incentive for production of those crops was examined by calculating Nominal Protection Co-efficient (NPC), Nominal Rate of Protection (NRP), Effective Protection Co-efficient (EPC) and Effective Rate of Protection (ERP). Results showed that there are reasons for protecting these crops from import substitution.

A measure of comparative advantage was used to examine the efficiency of using resources to produce CGPRT crops at home instead of importing them from abroad. Calculated DRC (domestic resource cost) values for maize, millets, lentil and potato suggest that the country will gain from producing more units of these crop products at home instead of importing them from other parts of the world. The DRC values were positive for potato even at export parity level during the most recent years implying that Bangladesh has the potential for export promotion through the production of more potato. The study reveals that the country has substantial potential for diversifying crop agriculture through the expansion of secondary crops (CGPRT crops).

The marketing of CGPRT crop products is inefficient. Over 80 per cent of major CGPRT products are marketed, but they suffer from significant seasonal price fluctuations. Farmers do not receive the benefits of higher prices as the time from harvest grows. The

grower's share of consumer price during harvest is above 60 per cent for maize, millets and pulses. It is relatively low however, for potato and sweet potato. Farmers are likely to benefit from a reduction in marketing costs and margins of tubers.

Recent market liberalization has resulted in a reduction of tariff rates and withdrawal of production subsidies. As a result, imports of some major CGPRT products, particularly maize and pulses have increased. It is possible to significantly increase the production of these crops provided new technologies are researched and disseminated and policies are framed conducive to technology adoption. In view of the above circumstances, more investment on yield increasing technology generation and adoption is necessary to meet the current deficit in CGPRT products and accelerate the speed of diversity in agriculture.

Bangladesh is a poor country with low per capita income. About 50 per cent of the population live below the poverty line. Most of them suffer from chronic malnutrition. CGPRT crop products are less expensive than major food items and even the poorest of the poor have access to coarse grains, pulses and tubers. These products have a higher nutritional value than major cereals. These products are rich in protein, fat, minerals and fiber and are also used as livestock feed. These crops are cultivated by relatively poor farmers under harsh environmental conditions. Expanding the production of these crops will intensify the farming system, create additional employment, and reduce the magnitude of poverty and nutritional deficiency in the country.

The demand for CGPRT crops is likely to increase with increases in population. The demand will increase further with the expansion of processing facilities and industrial uses of these crops. However, farmers are unaware of many processing techniques and the linkages between production, processing and utilization are weak. The increase in purchasing power of the common people and urbanization have increased demand for processed CGPRT crop products. This will encourage farmers to grow more of these crops for higher consumption and income.

There are, however, some constraining factors that hinder progress in production of CGPRT crops. They include low yield rates, lack of price incentives, lack of credit, poor knowledge of nutritional value and limited industrial uses. An increase in cold storage, credit, processing and marketing facilities would stimulate industrial uses and consumption of those products. Intervention from the government in product markets is also necessary to encourage production of CGPRT products and crop diversification.

In conclusion, it appears that maize, millets, pulses, potato and sweet potato (CGPRT or secondary crops) have enough potential for crop diversification, employment creation, income generation, reducing malnutrition and poverty alleviation in rural Bangladesh. These crops are profitable and have comparative advantage in production. The demand for these crops is likely to increase with urbanization and increases in per capita income, and the scope of industrial uses of these crops is high in the country. Therefore, farmers should be encouraged to produce more of these crops through area expansion and adoption of improved technologies in the process of production and consumption. Specific recommendations for the promotion of production and utilization of CGPRT crops are summarized below in order to guide policies and research in the country in future.

Recommendations

- Special subsidies should be provided for inputs to be used in CGPRT crop farming to encourage production.
- Farmers should be protected from international competition through the imposition of high tariffs on imports of CGPRT crop products. (The rate of tariff on CGPRT crops is very low, only 7.5 per cent and this is the main reason for higher imports and

discouragement of domestic production of CGPRT crops, although Bangladesh has comparative advantage in production.)

- Breeding and agronomic research for the generation of improved technologies in the production of CGPRT crops should receive high priority. This will call for high budgetary provisions for research on CGPRT crops.
- Attention should be given on cropping system research with emphasis on CGPRT crops.
- Appropriate irrigation measures and pest control policies have to be designed carefully for CGPRT crops.
- Cold storage facilities should be extended for sweet potato.
- Farmers producing CGPRT crops should be provided with production loans and small processors should be brought under the network of micro credit.
- The storage-cum-credit scheme should be extended to CGPRT crops.
- More processing plants and mills should be established at the intensive CGPRT crop growing zones to shorten the marketing channel and reduce marketing costs.
- Better transportation, communication and information systems should be developed to minimize spatial price difference.
- Traditional processing devices need to be improved. Also, attention should be given to modernization and capacity utilization of processing mills and plants. Commercial use of CGPRT crop products for animal feed and as raw materials to industry has to be explored and encouraged.
- A rational price policy should be formulated to ensure remunerative prices to CGPRT crop growers. This can be made effective through the procurement of produce by the government from the growers. A price commission should be established.
- Most people in Bangladesh do not know the high calorie and protein content of CGPRT crops. They need to be made aware of it through extension agents and mass media.
- Regional cooperation is required to carry forward research and development activities for promotion of diversification through secondary crops.

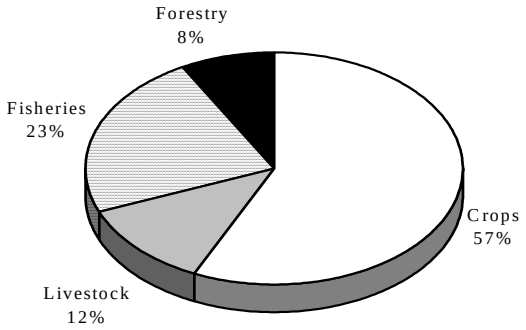
1. Introduction

1.1 Background

Agriculture in Bangladesh remains the single most important sector of the economy, contributing 23 per cent of the country's GDP at constant 1995-1996 prices. This sector employs 62 per cent of the country's total labour force. Exports of agricultural products, including jute goods and leather, accounted for 14.3 per cent of total exports in 2001-2002. The role of agriculture is crucial for food security, employment generation, poverty alleviation and sustainable economic growth.

The crop sector dominates the agriculture of Bangladesh accounting for 57 per cent of agricultural GDP at current prices. The contributions of fisheries, livestock and forestry sub-sectors to agricultural GDP are 23 per cent, 12 per cent and 8 per cent respectively (Figure 1.1). Rice, wheat, pulses, oilseeds, sugarcane, potato, vegetables, jute and tea are the main crops of Bangladesh. Rice dominates the crop sector of the country with more than 75 per cent of the domestic total cropped area under rice cultivation.

Figure 1.1 Composition of agricultural GDP (2002-2003)



There is enough scope to diversify the agriculture from rice to non-rice cereals, from cereals to non-cereal crop agriculture, and from crop to non-crop agriculture in the near future. The potential for expansion of the non-farm sector, particularly of the agro-processing sector is also very bright for sustained economic growth and poverty alleviation in rural Bangladesh.

The new seed-fertilizer-irrigation technology has favoured rice and wheat production for achieving self-sufficiency in food grains. As a result, production of food grains has increased at an annual growth rate of 2.8 per cent over the last 31 years mainly due to research and development efforts since the 1970s. Meanwhile, upland crops including coarse grains, pulses, roots and tubers (CGPRT), which occupy a significant portion of cropped area became less attractive. These crops grown in less favoured environments were largely untouched by the growth process, but did benefit from research efforts at BARI and have experienced long-term moderate growth. Nevertheless, some of these crops, for example some pulses and tubers, have been exhibiting a declining trend in most recent years. The country has become more dependent on imports of maize (Figure 1.2) and pulses (Figure 1. 3) to meet the growing demand for food, animal feed, fuel and industrial uses. Production of these crops needs to be promoted for import

substitution. These crops provide substantial opportunities for value addition after processing and creation of employment for women. Thus, there is sufficient scope for diversification of the rural economy through the promotion of CGPRT crops in Bangladesh.

Figure 1.2 Imports of maize in Bangladesh

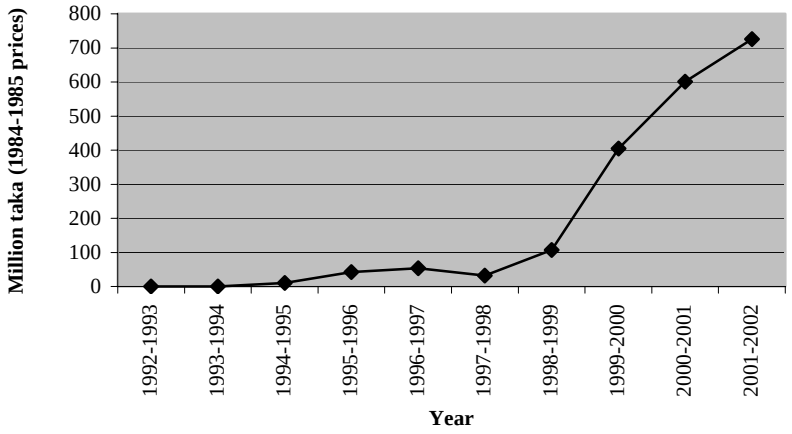
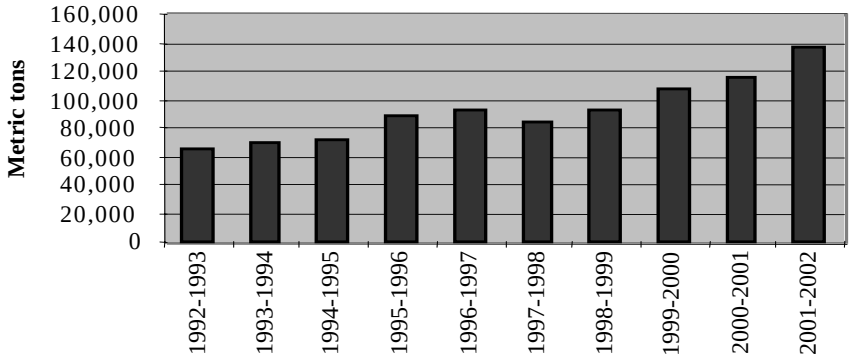


Figure 1.3 Imports of pulses in Bangladesh



The intensification of rice farming in Bangladesh has resulted in a slowdown of productivity and degradation of soil in some areas. The diversification of agriculture would help improve soil health, increase productivity, ensure food security, mitigate risk and protect the environment. This would also increase employment opportunities and the income of the poor people in rural areas.

This report presents the current status of some selected CGPRT crops (secondary crops) and examines their potentials in enhancing the sustainable development of diverse agriculture in Bangladesh.

1.2 Policy reforms

Bangladesh has been undergoing structural reforms aimed at liberalizing the economy to make it market oriented by reducing the role of the government. The distribution of agricultural inputs has been privatized, input subsidies have been phased out, and total AMS has been reduced to less than 1 per cent. The external trade sector has been liberalized through the elimination of non-tariff barriers and a steady reduction in import tariffs. The average tariff rate has been reduced from 57 per cent in FY 1991-1992 to 16.41 per cent in FY 2002-2003. Traditional agricultural imports face lower border protection than other imported commodities due to the country's dependence on food imports. Currently there is hardly any import duty on maize, and pulses are subject to a low tariff rate of 7.5 per cent.

The import parity price of maize is well above the domestic market price. For pulses, domestic prices are much above the world prices but they still remain below import parity prices (Table 1.1). Nevertheless, there is a huge gap between domestic demand and local production for some of the CGPRT crop products. The gap is met through imports. It is necessary to examine possibilities of import substitution and export promotion through increased production of CGPRT crops (secondary crops) in the country.

Table 1.1 Import parity prices of selected CGPRT crop products at the wholesale level (taka per metric ton)

Product/Year	Domestic wholesale price	International market price	Import parity price	Domestic price as a percentage of import parity price
Maize				
1999-2000	7,000	4,436	7,340	95.37
2000-2001	7,800	4,834	7,985	97.68
2001-2002	8,500	5,700	9,127	93.13
Millets				
1999-2000	11,000	9,834	15,492	71.00
2000-2001	11,500	10,660	16,351	70.33
2001-2002	12,000	11,428	17,559	68.34
Lentil				
1999-2000	23,720	21,629	27,162	87.33
2000-2001	35,660	30,514	37,603	94.83
2001-2002	35,700	21,238	26,978	132.33
Potato				
1999-2000	8,610	6,539	9,808	87.79
2000-2001	5,030	6,636	10,088	49.86
2001-2002	5,960	7,290	11,021	54.08

Source: Directorate of Agricultural Marketing, Dhaka and FAO, Rome.

Note: Domestic prices are the estimated average prices at wholesale level. International prices are f.o.b. at port in USA. For computing import parity prices, first a freight cost of US$ 40 per metric ton (including cost of insurance) has been added across the board to derive an estimated c.i.f. price for the product. Then the c.i.f. prices have been multiplied by a factor 1.15 to obtain the import parity prices at wholesale level.

Recent policy deliberations in Bangladesh have emphasized the need for diversification of agriculture to reduce the food gap and nutrition deficiency in the country. The agricultural policy document of the Ministry of Agriculture (GOB, 1999) has categorically mentioned the importance of diversification for sustainable growth in agriculture. The draft poverty reduction strategy paper (PRSP) of the Ministry of Finance (GOB, 2003a) has also advocated for agricultural diversification with a view to rural employment generation and poverty alleviation in the country. Moreover, the Fifth Five Year Plan (GOB, 1998) has noted the intention of the government to promote agricultural diversification for increasing farmers' income and maintaining sustainable production growth in future.

1.3 Objectives of the study

i. To find out the current status of CGPRT crops in relation to area, production, yield, consumption and marketing.
ii. To determine the magnitude of agricultural diversification and analyze the existing policies of the government in relation to diversification.
iii. To determine the profitability and comparative advantage of producing CGPRT crops.
iv. To calculate marketing costs and margins of products of CGPRT crops.
v. To analyze the impact of recent economic reforms and trade liberalization on upland CGPRT crops.
vi. To explore the potential of alleviating poverty through the development of CGPRT crops.
vii. To assess the demand for CGPRT crops and explore the potential to meet the changing demand.
viii. To investigate the nutritional and /or industrial importance of CGPRT crops as well as diversified ways of consuming them and to explore the potential of product diversification to meet changes in demand.
ix. To examine constraints to and prospects of crop diversification with CGPRT crops.
x. To recommend policies for enhancing the production and consumption of CGPRT crops in Bangladesh and elsewhere in the region.

1.4 Scope of the study

The study deals with a pressing need of the country, i.e. research on some selected secondary crops (CGPRT crops) with a view to examine the possibilities of promoting diversified agriculture in Bangladesh. The country, after achieving self-sufficiency in rice production, has now been consistently pursuing policies of crop diversification and emerging action programmes would require detailed information on the production of secondary crops. This study attempts to provide planners with that information and offers interpretation of results of sophisticated economic analysis and comments on the future direction of agricultural policy.

Agriculture in Bangladesh is composed of crop, livestock, fisheries and forestry sub-sectors. This study deals primarily with crop agriculture and the scope of diversification is limited to crop diversification rather than agricultural diversification. The objectives of this study are examined on the basis of data generated from secondary sources and field surveys. The areas under field surveys are not necessarily representative of all the regions of the country. Nevertheless, the data was collected and analyzed using the most modern techniques and the results of the study are likely to give some useful insights to guide policy measures on agricultural diversification and sustainable development. Further, the results of this study may provide other researchers with some vital information and queries on the agrarian economy of Bangladesh.

2. Methodology

2.1 Survey and analytical methods

This study collected and analyzed a large volume of primary and secondary data to fulfill the objectives of the study. Secondary data available in various statistical bulletins, reports and official records was assembled and at the same time primary data was collected from the field to complement the secondary data. The combined data was analyzed using appropriate statistical techniques.

Trends on production, consumption, exports, imports and prices of CGPRT crop products were analyzed using a 32-year database, starting from the early 1970s. They were presented in tabular and graphical forms. Moreover, growth rates of those variables were calculated for every successive decade so that the effect of policy changes could be examined very closely for each period of time.

In Bangladesh three successive time phases of policy changes can clearly be identified. These are: the phase of intensive intervention, the initial phase of liberalization, and the phase of economic reform or the period of open economy (Alam, 2004). The first phase starts from 1972 through to 1980, when agriculture enjoyed heavy subsidies and protection, and the public sector was responsible for input distribution. Phase two, initiated in the late 1970s and effective throughout the 1980s was marked by the gradual withdrawal of subsidies from agricultural inputs and privatization of the input distribution system. During that period, Structural Adjustment Policies of the World Bank and IMF influenced government policies. Phase three starts from 1991 to the present day, when the economy relies more on market forces and state intervention has been substantially reduced. There has been a substantial reduction of tariff rates on imports and a reduction of subsidies for agricultural inputs.

While analysis of historical data was made to determine the effect of policy changes on production and diversification of crops, primary data was made available from field surveys to know the current structure of incentives in agriculture. To evaluate quantitatively the diversity of income from crops a diversity index was used. That would perhaps be helpful to undertake or initiate policies for sustainable development of a CGPRT crop based farming system. Field surveys were conducted by trained field investigators of BARI and supervised by two scientific officers and team members.

An important aspect of looking at the incentive structure was to determine the magnitude of profitability of producing CGPRT crops in Bangladesh. For this purpose, primary data was collected from farmers of 12 districts of the country representing the most concentrated areas of the crop. The districts surveyed, including the capital Dhaka, are shown in Figure 2.1. A brief description of the districts surveyed is presented in Appendix C.

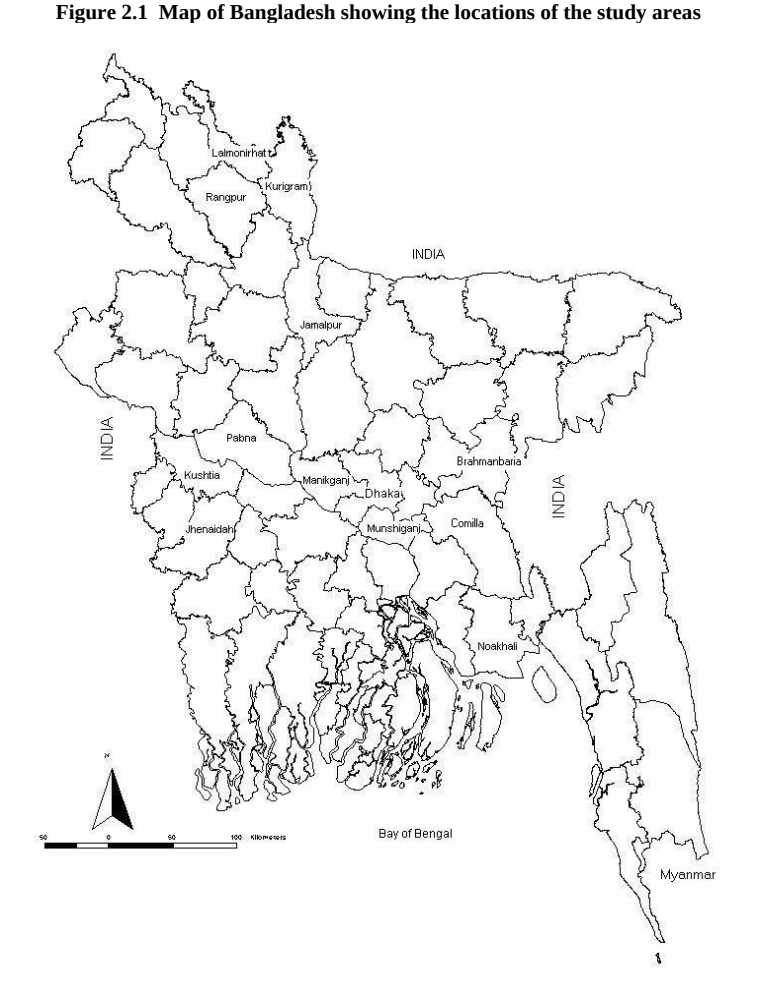
Data was collected from respondents by field visits using a structured questionnaire. The size of samples varied from 30 to 80 for each crop (Table 2.1) depending upon the nature of crop and the number of total farmers available for the survey in selected areas. The selection of samples was made following a simple random sampling technique. Other than the survey method, rapid rural appraisal (RRA) technique and participatory rural appraisal technique (PRA) were used for the collection of data on different variables. The detailed field survey was conducted from September to December 2003 covering one crop season for the financial year.

Both financial and economic analyses were carried out to determine the profitability of each crop. The comparative advantage or economic efficiency in producing CGPRT crops was determined by calculating net economic profitability (NEP) and domestic resource cost (DRC).

Table 2.1 Areas covered by the field survey and the size of sample in each area

Sl No.	Crop	Name of the site	No.of samples
1.	Maize	Manikgong	40
		Lalmonirhat	40
		Sub total	80
2.	Potato	Munshiganj	40
		Rangpur	40
		Sub total	80
3.	Sweet Potato	Noakhali	30
		Jamalpur	30
		Sub total	60
4.	Lentil	Kushtia	30
		Jhenaidah	30
		Sub total	60
5.	Mung/Mungbean	Jhenaidah	30
		Pabna	30
		Sub total	60
6.	Cheena	Kurigram/Brahmanbaria	30
7.	Kaon	Lalmonirhat/Comilla	30
	Grand total		400

Figure 2.1 Map of Bangladesh showing the locations of the study areas



The future demand for CGPRT crop products was determined by using the anticipated population growth rate, growth rate of income and income elasticity of demand for these crops. The income elasticity of demand was computed from a cross-section of consumption figures obtained through the HIES 2000.

Another aspect of the study was to identify the marketing channel, determine marketing costs and margins, and ascertain the disposal pattern of CGPRT crops. For this purpose, data was collected from farmers, market intermediaries, retailers and consumers by using structured questionnaires. Moreover, participatory rural appraisal method was used to examine the pattern of consumption, storing, processing and marketing of CGPRT crop products in the country.

The most significant part of the study was to see how domestic prices of CGPRT crop products differ from that of world prices. This was examined by collecting domestic and international market prices over time and calculating price ratios between the two markets. Moreover, export and import parity prices, nominal protection coefficient (NPC), effective protection coefficient (EPC) and their rates were calculated for CGPRT crop products to determine the position of Bangladesh in the world market.

2.2 Formation of study team

1.	Dr. Jahangir Alam Member-Director, BARC	Chairman
2.	Mr. Kazi Mesbahul Alam Principal Scientific Officer, Agril. Economics, BARI	Member
3.	Dr. Md. Abdul Quayyum Principal Scientific Officer, On Farm Research Division, BARI	Member
4.	Mr. Nazrul Islam Senior Scientific Officer, Agril. Economics, BARI	Member
5.	Mr. Md. Fozlul Haque, Deputy Director (Monitoring), DAE	Member
6.	Dr. S. M. Fakhrul Islam, Associate Professor, Department of Agricultural Economics, Bangabandhu Sheikh Mujibur Rahman Agricultural University	Member
7.	Mr. Fakir Azmal Huda, Assistant Professor, Department of Agricultural Economics, Bangladesh Agricultural University	Member
8.	Ms. Fatema Wadud, Deputy director, Shoshaya Gudam Rin Prokalpa, DAM	Member
9.	Mr. Naser Farid, Deputy Chief, FPMU, Ministry of Food	Member
10.	Mr. Ershadullah Khan, Deputy General Manager (Research), Bangladesh Bank	Member
11.	Mr. Md. Abdullah, Deputy General Manager (Statistics), Bangladesh Bank	Member
12.	Informed persons from Tariff Commission, Ministry of Agriculture, Ministry of Finance	Consulted

13.	Mr. Md. Sayedur Rahman, Scientific Officer, Agricultural Economics Division, BARI	Co-opted
14.	Mr. Tanvir Mahmud Bin Hossain, Scientific Officer, Agricultural Economics Division, BARI	Co-opted
15.	Mr. Mohammad Ismail Khan, Department of Agricultural Economics, Bangabandhu Sheikh Mujibur Rahman Agricultural University	Co-opted

The study team met from time to time to discuss academic issues and provide necessary inputs for the study. Some of the members were chosen by the national expert to assist him with data collection and processing. All members willingly cooperated and gave advice up until completion of the study. However, the author was solely responsible for the interpretation of study results and writing this report.

3. Socio-economic Profiles

3.1 Historical background

Bangladesh is an independent and sovereign country known as the People's Republic of Bangladesh. The country was declared an independent nation on 26 March 1971. The war of liberation ended on 16 December 1971 in victory for the Bangladesh freedom fighters and surrender of Pakistan's occupation army. This area was under Muslim rule for five and a half centuries and passed into British rule in 1757 AD. During the British rule it was a part of the British Indian province of Bengal and Assam. In August 1947 it gained independence from British rule along with the rest of India and formed part of Pakistan known as East Pakistan. The state language of the Republic is Bangla. The capital is Dhaka.

3.2 Area, location and population

Bangladesh has an area of 56,977 sq miles or 147,570 sq km. The country is situated in the north part of South Asia between $20^0$34' and $26^0$38' north latitude and $88^0$01' and $92^0$41' east longitude. The country is surrounded by India on the west, the north, and the north-east and Myanmar (Burma) to the south-east and the Bay of Bengal to the south.

Bangladesh is the most populous nation in the world with a population density of 834 per square kilometer. The total population of the country, according to the 2001 census, was 129.25 million. The annual compound growth rate of the population in the 2001 census over the adjusted 1991 census of population was 1.48 per cent. The number of households is 25.4 million. The average household size is 4.8 persons (unadjusted). The sex ratio is 103.8, which indicates that there are 103.8 males per 100 females. Life expectancy at birth is 60.6 years (Table A.1). The percentage of urban population is 23.4, while that of rural is 76.6. The adult literacy rate of the population, according to HIES 2000, is 44.5 per cent (male 49.5 per cent and female 40.1 per cent).

3.3 Climate and topography

The climate is tropical. It is humid and hot during summer, dry and mild during winter. Rainfall is heavy but extremely uncertain throughout the whole country. It varies from district to district, ranging from 30-150 inches (760-3,810 mm). Much of the precipitation occurs in the monsoon season, from May to October. During the peak period of the rains the water level rises by about 20 feet (6m) above sea level provided the flood is normal. In the years of high flooding the water level rises up to 30 feet (9m). Normally, two-thirds of the country goes under water during the rainy season.

Bangladesh is a delta region, crisscrossed by canals and rivers and washed annually by the mighty rivers - the Magna, the Padman, the Jamuna and the Karnafuli and their numerous tributaries. The greater part of the country is plain, the exceptions being the Chittagong hill tracts in the southeast of the country, the hills and hillocks of Sylhet, outlines of Garo hills in the northern part of Mymensingh district, and a stretch of small hills in Comilla.

3.4 Structure of economy

Economic structure refers to the relationship among the various sectors of the economy. Generally three main sectors, namely primary, secondary and tertiary are broadly recognized. The primary sector includes economic activities that are directly related to nature. In many countries, agriculture (crop, livestock, forestry and fisheries), mining and hunting represent the primary sector. The secondary sector deals with the processing and transformation of the products of nature. Thus manufacturing and construction activities are incorporated into the secondary sector. The tertiary sector, commonly known as the service sector, includes household, commercial, financial, professional and governmental services. All goods and services produced within a country in a given time are distributed over the above three sectors.

Bangladesh Bureau of Statistics (BBS) furnishes data on annual value addition created by production of all goods and services in 15 groups. For convenience, we have broken them down into three groups: (1) agriculture (primary), (2) industry and construction (secondary) and (3) services (tertiary) sectors. Agriculture includes, crop, livestock, forestry and fisheries sub-sectors. All residual sub-sectors, other than industry and construction, have been grouped under the services sector.

Figure 3.1 Composition of real sectorial GDP in 2002-2003 (1995-1996 prices)

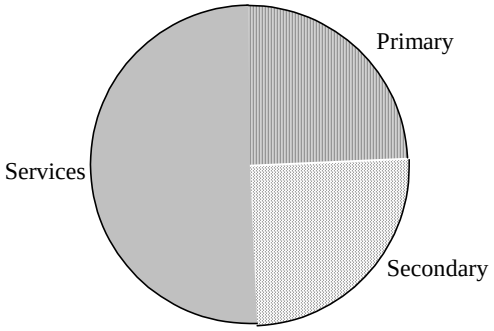


Figure 3.2 Real agricultural GDP at 1995-1996 prices

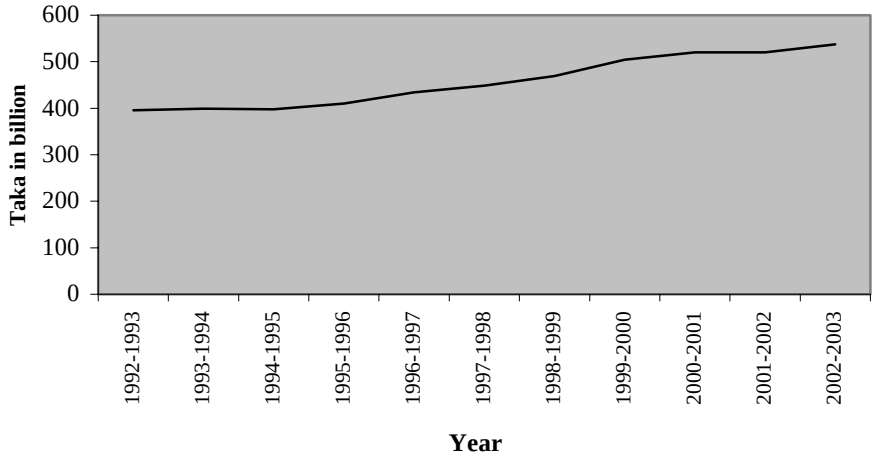


Figure 3.1 shows the composition of Bangladesh real GDP at 1995-96 prices. It can be noted that the share of the primary sector to GDP was 24.54 per cent in 2002-03. The secondary sector (industries and construction together) contributed 24.54 per cent to GDP, while the services sector contributed 50.92 per cent. The share of the primary sector to GDP has declined, secondary sector increased and that of the tertiary sector stagnated over time. The growth rates of the secondary and tertiary sectors have much superseded the growth rate in agriculture in most recent years (Table 3.1). Although the relative share of agriculture to GDP has declined over time, the contribution of agriculture to GDP in Bangladesh is still very high. Real agricultural GDP (at constant 1995-1996 prices) has experienced a 36 per cent increase from Tk 395,410 million in 1992-1993 to 537,340 million in 2002-2003 (Figure 3.2).

There has been a significant increase in agricultural production for the last four decades. The production of food grains increased from 9.7 million tons in 1960-1961 to 10 million tons in 1972-1973 and to 27 million tons in 2002-2003. As a result, per capita availability and consumption of cereals increased. The per capita intake of cereals was (459 grams per day) nearing the minimum requirement towards the end of the 20th century.

Table 3.1 Sectorial shares and growth rates of GDP at constant (1995-1996) prices

Sector	Shares (%)				Growth rates (%)			
	1992-1993	1995-1996	1999-2000	2002-2003	1992-1993	1995-1996	1999-2000	2002-2003
1. Crop, livestock and forestry	23.28	20.32	19.49	18.23	1.35	2.03	6.92	3.59
Crop	17.71	15.03	14.59	13.44	0.97	1.74	8.10	3.21
Livestock	3.56	3.36	3.02	2.93	2.38	2.51	2.74	4.51
Forestry	2.01	1.93	1.88	1.87	2.97	3.46	4.94	4.97
2. Fisheries	4.93	5.36	6.09	5.23	8.49	7.39	8.87	2.33
3. Mining and quarrying	0.96	1.05	1.03	1.08	8.91	7.81	9.48	6.32
4. Manufacturing	13.82	15.43	15.40	15.91	8.62	6.41	4.76	6.62
5. Construction	6.04	6.89	7.84	8.63	5.99	8.50	8.48	8.29
6. Power, gas and water	1.45	1.50	01.43	1.55	7.01	5.43	6.78	8.86
7. Trade	12.33	12.91	13.35	13.91	3.08	4.63	7.30	6.66
8. Hotel and restaurant	0.60	0.61	0.63	0.67	4.98	4.98	6.94	7.00
9. Transport and communication	9.00	9.07	9.20	9.78	3.04	5.15	6.08	7.33
10. Banking and insurance	1.55	1.58	1.57	1.63	2.84	4.87	5.50	6.96
11. Real estate	9.74	9.46	8.88	8.46	3.37	3.40	3.83	3.50
12. Public administration	2.49	2.52	2.55	2.63	14.77	4.16	5.97	6.93
13. Education	2.06	2.07	2.20	2.36	7.50	2.57	7.74	7.87
14. Health	2.35	2.28	2.20	2.21	5.32	2.70	4.80	5.82
15. Social services	9.40	8.95	8.13	7.71	2.72	2.78	3.06	3.43

Source: Bangladesh Bureau of Statistics.

Crop agriculture in Bangladesh is dominated by rice production. Rice contributes about 69 per cent to the value of crop output. Other crops including vegetables, fruits, tubers, spices, jute, sugarcane, pulses and oilseeds also make significant contributions to the total value of crop output (Table 3.2). However, the extent of crop diversification is low because cereals (rice and wheat) alone represent little over 72 per cent of the value of crop output in Bangladesh.

Non-crop agriculture includes livestock, fishery and forestry sub-sectors. The country suffers from a huge shortage in this sub-sector. The per capita annual availability of meat, milk and eggs is 4 kg, 12 liters and 20, respectively. In this case, the deficit ranges from 80 to 90 per cent. The per capita availability of fish is also very low (9.6 kg per year). The availability of fish, meat and eggs per day per person has, however, increased in recent years. The per capita consumption of those food items has also increased.

The possibility of augmenting the nutritional deficiencies through diversification of agriculture; through a shift from crop to non-crop agriculture seems very high. The growth rate of the non-crop agricultural sector has been high in recent years. Output from this sector (livestock, fisheries and forestry sub-sectors) has a higher nutritional and economic value than the crop sector. A farmer can produce and earn more from the non-crop sector compared to the production of crops from a unit of land, if production, processing and marketing systems for these non-crop activities are properly organized. Only a deliberate and concerted effort can help a farmer to exploit the full production potential of livestock, fishery and forestry enterprises, most of which are still located within the household economy, making an integrated system of farming in the country.

Table 3.2 Share of different crops in total value of crop output

(%)

Crops	2000-2001	2001-2002	2002-2003	Average
Rice	69.28	68.16	68.77	68.73
Wheat	3.51	3.46	3.15	3.37
Others cereals	0.11	0.40	0.43	0.32
All cereals	72.90	72.02	72.35	72.42
Potato	3.21	3.45	3.48	3.38
Sweet potato	0.39	0.33	0.30	0.34
Tubers	3.60	3.78	3.78	3.72
Vegetables	4.74	4.68	4.66	4.69
Pulses	1.95	1.99	1.94	1.96
Oilseeds	1.58	1.51	1.42	1.50
Spices	3.38	3.30	3.22	3.30
Jute	2.25	2.51	2.25	2.34
Cotton	0.13	0.29	0.24	0.22
Sugarcane	2.31	2.26	2.29	2.29
Fruits	4.02	4.36	4.57	4.32
Tobacco	0.27	0.27	0.26	0.27
Tea	0.88	0.85	0.84	0.86
Others	1.99	2.18	2.18	2.11

Source: Bangladesh Bureau of Statistics.

In most recent years, the rural non-farm (RNF) sector has been expanding at a much faster rate than the farm sector. A recent study (Hossain, 2002) shows that income from RNF activities increased at 6.8 per cent per year between 1987-1988 and 2000-2001. Currently, non-farm activities account for 52 per cent of rural household income and 40 per cent of rural employment. The growth in the RNF sector was largely attributed to an impressive growth in the crop and non-crop agricultural sectors that increased RNF activities through backward and forward linkages and was reinforced by the expansion of micro-credit facilities and the development of physical infrastructure. It is most likely that rural non-farm activities including rural manufacturing, food processing, trade and services will create more employment opportunities and generate more income for rural people in the near future.

3.5 Land distribution, income and inequality

Availability of land for cultivation is insufficient and its distribution is unequal in Bangladesh. The per capita availability of land for cultivation was 0.14 acres (0.057 ha) in 1996, which had declined from 0.25 acres (0.10ha) in 1983-1984. The average size of farm holding has declined from 1.67 acres (0.68 ha) in 1983-1984 to 1.15 acres (0.47 ha) in 1996. The land area under operation has declined from 9.2 million ha in 1983-1984 to 8.2 million ha in 1996, indicating that about 235 ha of land is going out of agriculture every day. The number of farm households has increased from 10 million in 1983-1984 to 11.8 million in 1996 giving an annual growth rate of 1.3 per cent. The number of households owning less than 0.5 acres (0.20 ha) of

land (functionally landless) grew from 6.4 million (46 per cent of rural households) in 1983-1984 to 10 million (56 per cent) in 1996. The number of large, medium and small farmers has, however, declined considerably during that period (Table 3.3). The Gini co-efficient for land distribution has declined from 0.68 in 1983-1984 to 0.66 in 1996 but the distribution still shows high inequality of land ownership in rural areas.

Table 3.3 Changes in the distribution of landownership, 1983-1984 to 1996

Size of holding (acre)	1983-1984		1996		Annual growth rate (%)
	No. of households ('000)	Percentage of households	No. of households ('000)	Percentage of households	
Nil	1,198	8.7	1,815	10.2	3.4
0.01 to 0.49	5,200	37.6	8,172	45.8	3.7
0.50 to 2.49	4,639	33.6	5,473	30.7	1.4
2.50 to 4.99	1,598	11.6	1,458	8.2	-0.8
5.00 to 7.49	650	4.7	541	3.0	-1.6
7.50 to 24.99	504	3.6	350	2.0	-3.0
25.00 and above	28	0.2	19	0.1	-3.2
Total	13,818	100.0	17,828	100.0	2.1

Source: Agricultural Census, 1983-1984 and 1996.

Bangladesh is one of the poorest countries in the world with annual per capita income below 400 dollars (about US$ 390 in 2002-2003). During the last three decades, the GDP increased by about 4 per cent per year, much of that growth was absorbed by the growth in population. The growth rate of GDP was 4.5 per cent during the 1990s. This growth was, however, accompanied by growing income inequality. The Gini coefficient of income distribution increased from 0.398 in 1991-1992 to 0.432 in 1995-1996 and further to 0.472 in 2000. This increase indicates that the uneven distribution of income has been widening in Bangladesh over the years.

3.6 Unemployment

Unemployment and underemployment is considered as the most pressing of all problems in an economy. The International Labour Organization (ILO) defines unemployed as members of the economically active population who are without work but available for and seeking work, including people who have lost their jobs. There is another group of people who do not have work for part of a period of the reference year and they are categorized as underemployed. The unemployment rate is the percentage of the labour force that actively seeks work at a given time. The age of the working population in Bangladesh is 15 years and over (excluding child labour of 10 years and over).

The size of the labour force in Bangladesh was 36.1 million in 1995-1996, increasing to 40.7 million in 1999-2000, giving a growth rate of 3.2 per cent per year. The male labour force increased by 1.2 per cent while the female labour force increased by 14.4 per cent. Over the years, the rate of employment in agriculture declined but increased in trade, hotel and transport services (Table A.2). The absorption capacity of the economy did not grow as per the growth rate of total labour force. As a result, the rate of unemployment increased.

Table 3.4 shows an increasing trend in the rate of unemployment, although it remained very low at 3.7 per cent in 2000. This does not represent the real magnitude of unemployment in the labour market. When an extended definition of unemployment (unpaid family helpers working less than 15 hours per week) is considered, the magnitude rises to 11 per cent. The proportion of underemployment (share of employed persons working less than 35 hours during the reference week) exceeded 35 per cent in 2000, even though the trend has been declining since 1991. Underemployment is high in the agricultural sector (46 per cent) and is particularly

acute among women (72 per cent). The unemployment and underemployment rates are higher in rural areas than in urban areas.

Table 3.4 Unemployment and underemployment rates

Sectorial	1990-1991	1995-1996	1999-2000
Unemployment	1.9	2.5	3.7
Extended unemployment	18.3	16.5	11.0
Underemployment	43.0	34.6	35.3

Source: Labour Force Survey 2000 (GOB, 2002) and World Bank (2003a).

The index of real wages in agriculture declined during the late 1980s but recovered in the early 1990s. The real wage index in agriculture stood at 112 in 2001-2002 (Table A.3). Compared with other sectors of the economy, agriculture has witnessed the lowest growth in wage rates over time.

3.7 Incidence of poverty

The incidence of poverty is alarming in rural Bangladesh, although a significant improvement has been made in recent years. The estimate based on a household expenditure survey showed that the head count ratio of poverty for 1991-1992 was 58.8 per cent. The situation has improved over recent years and the percentage of people living in absolute poverty fell to 49.8 per cent in 2000. Similarly, the extreme poverty rate declined from 43 per cent to 34 per cent over the same period (Table 3.5). Thus the magnitude of poverty declined by about 9 per cent over the nine-year period, i.e. 1 per cent per year. Trends in poverty gap and squared poverty gap measures suggest that a greater share of poor people are now closer to the poverty line than they were at the beginning of the decade. The improvement can be explained by a significant increase in domestic food-grain production and increases in per capita income (Table A.4) that enhanced the purchasing power of the poor during the last decade. However, the incidence of poverty is still very severe in Bangladesh.

Table 3.5 Trends in magnitude of poverty (cost of basic needs or CBN method)

	Upper poverty line (absolute poverty)			Lower poverty line (extreme poverty)		
	1991-1992	1995-1996	2000	1991-1992	1995-1996	2000
Head count ratio						
National	58.8	51.0	49.8	42.7	34.4	33.7
Urban	44.9	29.4	36.6	23.3	13.7	19.1
Rural	61.2	55.2	53.0	46.0	38.5	37.4
Poverty gap						
National	17.2	13.3	12.9	10.7	7.6	7.3
Urban	12.0	7.2	9.5	4.9	2.6	3.8
Rural	18.1	14.5	13.8	11.7	8.6	8.2
Squared poverty gap						
National	6.8	5.4	4.5	3.9	2.5	2.3
Urban	4.4	3.4	3.4	1.5	0.7	1.2
Rural	7.2	5.7	4.8	4.3	2.8	2.6

Source: Household Expenditure Surveys, 1991-1992; 1995-1996; 2000.

Note: Cost of basic needs (CBN) method for estimating poverty lines represents the level of per capita expenditure at which the members of households can be expected to meet their basic need (consumption of food and non-food items). The estimates of the cost of basic food needs are the same with the lower and upper poverty lines. The difference between the two lines is due to the difference in estimation of the allowances for non-food consumption. The lower poverty line incorporates a minimal allowance for non-food goods while the upper poverty line makes a more generous allowance.
Poverty gap = 1-y/z, squared poverty gap = (1-y/z)2.
y: mean consumption of the poor, z: poverty line.

A number of targeted anti-poverty programmes that provided credit, training and extension support to the functionally landless people are in progress in the rural sector. Many of them are related to livestock, fisheries and social forestry development. There are also programmes in the rural non-farm sector. A large number of women are involved in these programmes generating self-employment and income for them. These programmes are carried out by the Bangladesh Rural Development Board, Grameen Bank, Bangladesh Rural Advancement Committee (BRAC) and other non-governmental organizations targeting the rural poor. They have contributed significantly to the reduction of poverty in Bangladesh.

3.8 Concern for the environment

The high population pressure and poverty in Bangladesh have resulted in the intensive use of land and water resources. As a result, there has been growing concern for the possible destruction of the ecosystem and biological diversity.

The increasing number of people have been applying pressure for building new homes and growing more food crops, particularly rice. As a result grazing land and vegetation are increasingly being destroyed. Moreover, indiscriminate use of fertilizers, pesticides and herbicides are not only destroying the quality of the soil but also disturbing the habitat of fishes and beneficial insects. Furthermore, heavy extraction of surface and groundwater for irrigation during the dry season has caused many water bodies to go dry. This has accelerated the process of environmental degradation resulting in loss of productivity, biodiversity and increased vulnerability to natural disasters.

Meanwhile, several programmes for the protection of the environment and conservation of plant and animal species have been undertaken both by the public and private sector to avoid any catastrophe. A shift from rice monoculture to diversified agriculture has also been advocated and an organic production system is in practice as an alternative to chemical agriculture.

3.9 Concluding summary

Bangladesh is a poor country with annual per capita income below US$ 400. The density of population per square kilometer is 834, one of the highest in the world. Agriculture is the main occupation of the population contributing around 23 per cent to the nation’s GDP. The share of the crop sector to agriculture is 57 per cent and rice alone contributes 69 per cent to the value of crop output. Poverty is endemic in the country with about 50 per cent of the population living below the poverty line. The distribution of income has been widening over time. There is growing concern for the diversification of agriculture to reduce hunger, malnutrition, unemployment and poverty, and secondary crops (CGPRT crops) offer one of the best possible options for increasing agricultural diversity in the country. It is expected that diversification in agriculture will help improve the livelihoods of the people and protect the environment.

4. Status of CGPRT Crops

4.1 Coarse grains

Cereals occupy 81 per cent of gross cropped area in Bangladesh. Cereals include rice, wheat, barley, bazra, maize, millets and sorghum. Rice and wheat constitute about 80 per cent of total cropped area.

Coarse grains occupy 0.79 per cent and maize occupies 0.23 per cent of the total area under cultivation. Some of these crops are less capital intensive and better suited to rainfed conditions. As for CGPRT crops, we are concerned mainly with barley, bazra, maize, millets and sorghum. These coarse grains account for 0.88 per cent of total food grain production.

Area under cultivation and production of barley, bazra and sorghum are insignificant. The major coarse grains in Bangladesh are maize and millets. In terms of production, millets constitute only 0.22 per cent of total grain production while maize constitutes 0.66 per cent. The growth rate of maize has been very impressive in recent years (15.13 per cent).

The area and production of millets have been stagnating over the last three decades (Table 4.1). Millets are poor-man's food. They deserve the attention of researchers and policy makers. There has been a sharp increase in area, production and yield of maize over time and it has been recognized as the third most important food grain crop in Bangladesh. Maize is grown both in the summer and winter seasons on 1.7 lakh (1 lakh = 100 thousand) hectares of land. Winter maize accounts for about 84 per cent of the country's maize harvest. Average production per hectare is 5.7 tons.

Current demand for maize is 5 lakh (500 thousand) metric tons. The demand is met from imports (68 per cent) and local production (32 per cent). The demand is likely to increase to about 9 lakh (900 thousand) tons by 2010. If the present trend of maize imports continues, the increased cost of imports will burden the balance of payment situation. Therefore, most of the demand for maize has to be met from local production. There is a potential of producing about 7 million tons of maize at a yield of 8 tons per hectare covering one third of the potential area (0.93 million hectares, as the Directorate of Agricultural Extension indicates).

Increased production of maize at home has given rise to a range of second generation problems relating to sowing, fertilization, shelling, drying, storage, processing and marketing. Some of these problems have already been taken care of by appropriate authorities. Nevertheless, the processing of maize into starch and other agro-industrial by-products such as maize oil, glucose, alcohol, syrup, baby foods and flakes is yet to be developed in the country. As a matter of fact, about 70 per cent of the total supply of maize is used as an ingredient of poultry feed. It would be worthwhile to examine how maize could be processed for value addition and human consumption in the country.

Table 4.1 Trend growth rates in area, yield and production of some major crops and CGPRT crops in Bangladesh

Crops	1971-1980			1981-1990			1991-2002			1971-2002		
	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
Rice	0.83	2.52	3.35	-0.15	2.90	2.75	0.63	2.89	3.52	0.18	2.44	2.62
Wheat	16.91	11.49	28.40	1.07	-2.93	-1.85	3.40	2.10	5.50	6.32	2.27	8.59
Other cereals	-3.39	-0.81	-4.19	2.45	0.20	2.65	-1.92	0.99	-0.93	-0.05	0.28	0.23
Maize	-4.37	-3.95	-8.32	3.88	7.31	11.19	20.51	17.31	37.82	7.97	7.15	15.12
Millets	-2.44	-0.79	-3.24	2.57	0.32	2.89	-1.65	-0.09	-1.74	0.98	0.08	1.06
All cereals	1.21	2.81	4.02	-0.06	2.53	2.47	0.81	2.85	3.66	0.40	2.41	2.81
Pulses	-4.05	3.79	-0.26	8.46	0.37	8.84	-4.75	1.03	-3.72	2.28	1.16	3.44
Lentil	3.48	-2.52	0.98	9.58	1.85	11.43	-2.76	0.19	2.57	4.45	0.81	5.26
Mung/mungbean	1.05	-3.68	-2.65	12.97	-0.02	12.98	-0.84	1.68	0.83	5.87	0.01	5.97
Lathyrus	1.42	-1.64	-0.22	9.69	-0.56	9.13	-3.27	1.28	-1.99	4.10	0.27	4.37
Black gram	-0.55	-1.91	-2.45	4.17	0.93	5.10	-10.09	-0.69	-10.78	-0.24	-0.06	-0.30
Gram	-1.27	-0.74	-2.03	0.56	-0.07	0.49	-17.52	0.11	-17.96	-0.11	-0.00	-0.11
Tubers	2.0	-0.04	1.96	-0.39	-0.80	-1.19	6.09	1.54	7.63	1.55	0.57	2.12
Potato	2.91	-0.95	2.72	1.23	-0.64	0.59	8.12	1.60	9.72	3.22	0.92	4.14
Sweet potato	0.83	0.22	1.05	-3.58	-0.98	-4.56	-214	-0.61	-2.75	-2.32	-0.49	-2.80
Oilseeds	0.79	0.35	1.14	7.06	-2.21	4.85	-2.89	1.02	-1.88	2.36	0.46	2.82
Vegetables	1.99	-0.46	1.53	2.7	-0.33	2.37	3.85	-0.22	3.63	2.80	0.06	2.86
Spices	-0.23	-1.21	-1.44	-0.40	1.19	0.79	5.66	-3.28	2.38	0.75	0.00	0.75
Tea	-0.28	0.27	-0.01	0.78	0.16	0.94	0.23	0.44	0.67	0.47	1.18	1.66
Cotton	-4.67	3.53	-1.14	0.01	3.89	3.9	7.49	-10.44	-2.95	7.80	3.04	10.84
Jute	-0.70	2.34	1.64	-1.56	1.31	-0.25	-2.06	1.31	-0.75	-1.73	1.37	-0.36
Sugarcane	1.06	0.79	1.85	1.65	-1.08	0.57	-1.23	0.04	-1.19	0.93	-0.33	0.60
Fruits	1.42	-1.46	-0.04	0.91	-0.59	0.32	0.98	-0.74	0.24	1.14	-0.87	0.27
Tobacco	1.83	0.65	2.48	-3.29	-1.08	-4.37	-2.24	2.05	-0.19	-1.83	0.93	-0.91

Source: Bangladesh Bureau of Statistics.
Note: Growth rates have been calculated by fitting semi-logarithmic trend lines.

4.2 Pulses

Pulses occupy 3.3 per cent of gross cropped area. They are the poor man's meat (protein) in Bangladesh. Important pulses include lathyrus, lentil, mung/mungbean, black gram, chickpea, field pea and pigeonpea. In terms of area, production and yield, lathyrus and lentil occupy the first and second position, respectively, of pulses in Bangladesh (Table 4.2).

Table 4.2 Share of different pulses in total pulses' area and production of Bangladesh (three years average from 1998/1999 to 2000/2001)

Pulse type	Area		Production		Production per hectare
	'000 ha	%	'000 ton	%	(ton)
Lathyrus	199.84	39.47	162.39	41.88	0.81
Lentil	178.92	35.34	139.77	36.05	0.78
Mung/mungbean	54.40	10.75	34.63	8.93	0.64
Black gram	28.42	5.61	20.53	5.29	0.72
Chickpea	16.48	3.25	12.08	3.12	0.73
Field pea	17.81	3.52	13.82	3.56	0.78
Pigeonpea	5.00	0.98	2.60	0.67	0.52
Others	5.26	1.08	1.92	0.49	0.34

Source: Bangladesh Bureau of Statistics.

Total area and production of pulses have shown a long-term increasing trend but have declined in recent years (Table 4.1). There was a little gain in the yield rate of pulses due to the adoption of new techniques, but that was more than offset by the decline in area under cultivation. The nominal prices of pulses have increased over time in the domestic market and they are much higher than the world market prices.

Production of pulses in Bangladesh is profitable. Available evidence shows that the benefit-cost ratio is positive for different types of pulses, particularly for lentil and lathyrus (Elias *et al.*, 1986). Even then the area under the production of pulses has been declining and farmers are trying to produce pulses with minimum tillage and cash inputs.

4.3 Tubers

Tubers account for 2.1 per cent of total cropped area. The principal tuber and root crops are potato and sweet potato, which occupy 276 thousand hectares and produce 3,440 thousand tons of main products. The area, production and yield of potato have increased, while that of sweet potato have sharply declined over time. Currently, potato accounts for 87 per cent of total production of tubers in the country.

The price of potato has declined in recent years. However, production continued to increase due to the adoption of improved techniques in potato cultivation. Consumption of potato has also increased significantly in the country.

Sweet potato is grown in all the districts of Bangladesh particularly on strips of sandy land rising out of riverbeds. Due to its low unit price, the rural poor use sweet potato as a substitute for rice. The decline in production of sweet potato has imposed a burden on the poor particularly at times when the price of rice becomes very high. The reasons for the gradual decline in area and yield of sweet potato deserve careful investigation.

4.4 Livestock population

The livestock population in Bangladesh is currently estimated to comprise 22.29 million cattle and buffalo, 14.61 million goats and sheep, and 126.67 million chickens and ducks (Table 4.3). The annual growth rate of the bovine population has been calculated as 0.19 per

cent between 1983-1984 and 1996. However, the chicken population showed a significant increase over that period with an annual growth rate of 4.16 per cent.

Between 1960 and 1996, the total human population increased by 124.95 per cent, but the bovine population increased by only 14.84 per cent. The bovine population has registered a very slow annual growth rate against that of the human population between these two periods (Table 4.3). Among other factors, the low birth rate, high mortality due to diseases and frequent natural hazards, the slaughter of good quality young cattle in large numbers on Eid-ul Azha (Islamic ceremony of sacrifice) and the unplanned slaughtering of cattle for meat throughout the whole year are the main reasons for the slow growth rate of the bovine population.

Table 4.3 Livestock population in Bangladesh

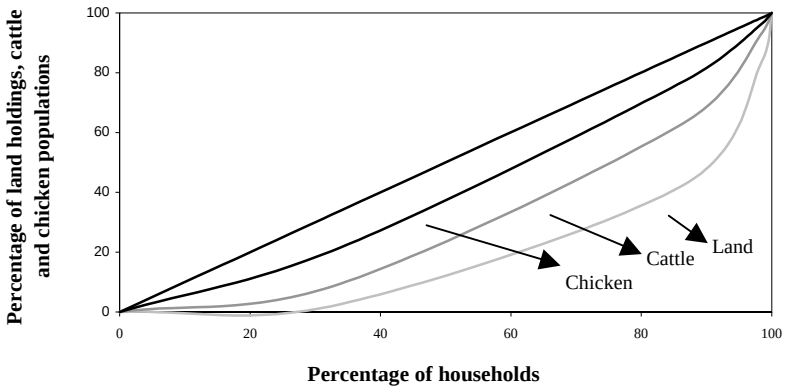
Species	Population (millions)				Annual growth rate [1]		
	1960	1977	1983-1984	1996	1960-1977	1977-1984	1984-1996
Bovine animals	19.41	21.04	21.74	22.29	0.47	0.46	0.19
Sheep and goat	6.15	9.01	14.23	14.61	2.25	6.53	0.20
Poultry and duck	20.10	53.59	73.72	126.67	5.77	4.55	4.16
Human population	54.53	82.71	96.14	124.30	2.45	2.15	1.98

Source: Agricultural Census of 1960, Agricultural Census of 1977, Agricultural Census of 1983-1984 (full count), Agricultural Census of 1996 and authors' calculation.

Note: [1] Calculated using the formula for annual percentage compound growth.

In Bangladesh, 84.5 per cent of total households own livestock (animals and birds or both). About 40 per cent of households possess bovine stock. The number of bovine animals per household is 1.2. Sheep and goats are reared by 19.7 per cent of households and their number per household is 0.57. About 53 per cent of households rear poultry. On average, there are 6.95 birds in each household. The number of animals and birds is 8.73 for an average household of the country. There are indications that the number of households keeping livestock has declined over time. The decline has been marked specially for households raising cattle and buffalo due to an increase in landlessness accompanied by an increase in the shortage of feeds and fodders. It appears that the distribution of livestock population over rural households has become more unequal in recent years although there is evidence that the degree of inequality is lower for cattle holdings than for land holdings (Alam *et al*., 1993). The Lorenz curves drawn from 1996 Census figures clearly show more inequality for land distribution and less for chicken and cattle distribution (Figure 4.1). The inequality measured by Gini coefficient is 0.66 for land distribution, 0.37 for cattle and 0.17 for the distribution of the chicken population.

Figure 4.1 Lorenz curves showing the distribution of land holdings, cattle and chicken populations in Bangladesh



4.5 Fodder production

An important constraint to livestock development is the acute shortage of feeds and fodder. Animals in the country depend mainly on rice straw for their nutrition. Poultry generally subsists on insects and post-harvest grain residues under scavenging systems. In milk pocket areas, some pulses are grown for milk cows but the area under pulses for fodder has been diminishing over time. Poultry farms under intensive management need balanced feed, but the supply of such feed has been restrained due to the high prices of feed ingredients. Thus the overall condition of livestock nutrition in the country is getting worse. The average daily intake of nutrition is very low for both animals and poultry resulting in low growth rates, body weight, milk yield, draught power (animal power used for ploughing, threshing etc.) output and egg production. An estimate shows that there is a shortage of 66.5 per cent green fodder and 89.9 per cent concentrates in the country (Table 4.4). The availability of straw is more than the requirement. The shortage of green fodder has been intensified mainly due to conversion of grazing lands into cereal lands. Currently there are only 3,290 acres (1,331ha) devoted to fodder cultivation (BBS, 1999). A micro study shows that only 2 per cent of the farmers cultivated HYV fodder and the area devoted to fodder cultivation per farm was only 0.002 acres (Alam *et al*., 1993).

Table 4.4 Requirement and availability of livestock feed (million metric tons (mt))

Feed	Requirement (million mt)	Availability (million mt)	Surplus/deficit (%)
Straw	16.27	20.51	+ 26.02
Green fodder	70.42	23.58	- 66.51
Concentrate	27.73	2.79	- 89.94

Source: Author's calculation.

Bangladesh is now self-sufficient in cereal production. Recent dietary patterns (Table A.5) suggest that a significant reduction in cereal consumption and production is desirable. Thus, a part of the land currently under cereal production can be released for fodder cultivation. Again, there is enough scope for a per unit increase in the yield of rice. Recent evidence shows that this country produces far below the average yield level of many countries of the world. If the production of rice can be increased by 20 to 30 per cent in the near future, at least 10 to 15 per cent of the cultivable land currently under paddy production will be freed for fodder cultivation. This will help minimize the current feed shortages.

4.6 Concluding summary

Secondary crops (CGPRT crops) under investigation include coarse grains, pulses, roots and tubers. Coarse grains occupy 0.79 per cent, pulses 3.3 per cent and tubers 2.1 per cent of the total cropped area of the country. The growth rates of millets, pulses and sweet potato have declined, but the growth rates of maize and potato have increased over the last decade. The area under fodder cultivation has declined over time imposing a severe constraint to production of animals and poultry in the country. The diversification of crop agriculture through the expansion of CGPRT crops will help minimize the shortage of human and animal nutrition in future.

5. Diversification of Agriculture

5.1 Introduction

Conceptually, diversification of agriculture is considered as a shift of resources from rice to other cereal crops, from cereals to non-cereal crops, and from crops to non-crop (livestock, fisheries and forestry) agriculture. Farmers normally intend to diversify to minimize risk, stabilize income over seasons, optimize the use of land and other resources, maximize the portfolio of income and profit, change the food habit, increase protein intake, improve food security, promote exports, substitute imports, conserve natural resources, create employment opportunities and alleviate poverty. Diversification may not always imply movement of resources from a low value commodity mix to a high value commodity mix, as that can increase the magnitude of specialization at the farm level and reduce the extent of diversity.

This study limits the scope of diversification to within crop agriculture and indicates the use of resources in a large mix of diverse and complimentary activities within the crop sector. The main resource in crop agriculture is land and the degree of diversification is reflected on the pattern of utilization of cultivated land. It is expected that land will be judiciously shared by a large number of crops under perfect diversification.

5.2 Simpson Index of diversification

A number of methods have been used to quantify the magnitude of diversification. They include: (i) Herfindal Index, (ii) Simpson Index, (iii) Ogive Index, and (iv) Composite Entropy Index. With a view to assess the degree of diversity in the crop sector, the Simpson Index was used in this study. The index provides a clear dispersion of crop agriculture in a particular region. The index ranges between 0 and 1. When there is complete diversification, the value of the index moves towards 1. The index was constructed as follows:

$$SID = 1 - \sum_{i=1}^{n} P^2_i$$

Where SID is the Simpson Index of diversity and P_i is the proportionate area of i^{th} crop in the gross cropped area. Several factors influence the nature and speed of diversification from the staple food crop to other crops. These factors include rapid technological change in other crops, diversification in food demand, and improvement in rural infrastructure. To determine the speed of diversification in favour of a particular crop, annual growth rates of area, production and yield of that crop were examined.

Table 5.1 Share (per cent) of different crops in total cropped acreage and SID over time

Crop	1972-1973	1989-1990	2001-2002
Rice	78.76	75.66	75.05
Wheat	0.98	4.28	5.54
Minor grains	0.78	0.63	0.79
Total grains	80.52	80.57	81.39
Pulses	2.57	5.32	3.34
Oilseeds	2.14	3.33	3.21
Spices	1.25	1.08	1.88
Vegetables	0.85	1.17	1.82
Tubers	1.17	1.22	2.06
Sugarcane	1.05	1.35	1.21
Jute	7.34	3.91	3.41
Others	0.03	0.62	1.68
Cropping intensity	144.95	168.44	177.00
SID	**0.37**	**0.42**	**0.43**

Source: Alam (2004), MOA (2003) and author's calculation.

For computation of SID, all crops grown in Bangladesh were grouped into eleven categories. They include rice, wheat, minor grains (maize and millets), pulses, tubers, oilseeds, spices, vegetables, sugarcane, jute, and other crops. Calculated SID showed an upward trend over time, from 0.37 in 1972-1973 to 0.42 in 1989-1990, and 0.43 in 2001-2002 (Table 5.1). Again, forty-four crops including all CGPRT crops were considered individually for SID computation without arranging them into groups. Time series data on land area under operation for different crops was taken from the Ministry of Agriculture (MOA, 2003). The analysis also showed that the SID for the country slowly increased from 0.753 in 1971-1972 to 0.768 in 2001-2002 with fluctuations in different years. The values of SID averaged 0.755 for the seventies, 0.782 for the eighties and 0.784 for the nineties including the first two years of the new millennium (Table A.6). This result supports Alam (2003) and Rahman *et al*. (2004), but contradicts Joshi, *et al*. (2003), who observed a negative trend of Simpson Index of crop diversity in Bangladesh. While it is recognized that Bangladesh has specialized in rice production over the years and about three-quarters of the area in the country is now under rice, it is also observed that within rice there is substantial diversity and the remaining one-quarter is highly diversified.

The magnitude of diversification was again examined from a different angle. This was calculated using the extent of concentration in rice cultivation over the years. The 'specialization index' (SP) was of the following form:

$$SPij = Rij / Ri, \quad Rij = Aij / \Sigma Aij, \quad Ri = Ai / \Sigma Ai$$

SPij: Specialization index of commodity i in region j
Rij: Proportion of commodity i in harvested area (gross cropped area) of region j
Ri: Proportion of commodity i in harvested area in whole country
Aij: Harvested area of commodity i in region j
Ai: Harvested area of commodity i in whole country

If SPij is more than 1, it means region j is specialized in commodity i in the country.

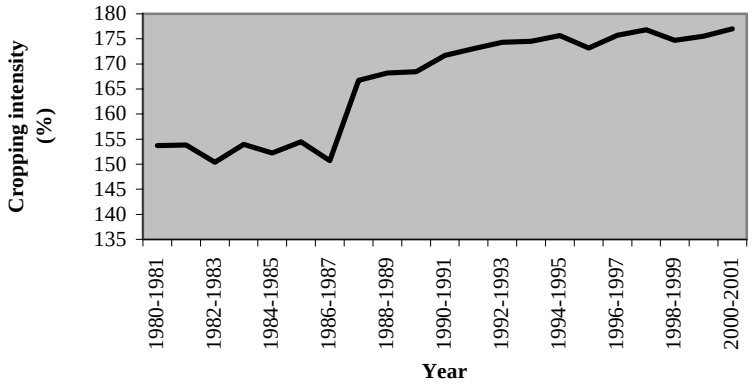
Results of calculations of SP by region are presented in Table 5.2. It appears from the table that Chittagong division was specialized in rice cultivation with SP value 1.19 in 1983-1984, when SP values for the other 3 divisions were close to 1. The values of SP for the country ranged between 0.94 and 1.19 by division. These values have slowly declined and in 1996 the SP values ranged from 0.80 to 1.14 in 4 divisions of the country. These results are consistent with our earlier results on crop diversification obtained from calculating SID.

Table 5.2 Specialization index of rice cultivation in Bangladesh by region

Division	Value of index	
	1983-1984	1996
Chittagong	1.19	1.14
Dhaka	0.94	0.80
Khulna	0.97	0.89
Rajshahi	0.98	0.97

Crop diversification is promoted by area augmentation and crop substitution. Bangladesh does not have much fallow land for utilization and the total area under cultivation has been declining in recent years (from 9.32 million hectares in 1983-1984 to 8.29 million hectares in 1996; or 235 hectares per day). The intensity of cropping has, however, been increasing steadily over time (Figure 5.1). This is certainly an important source of diversification. The other source of diversification is crop substitution. Over the years, area under rice and jute has declined, but the area under wheat and potato has increased. This is likely to proceed further if special policies are framed favouring the cultivation of CGPRT crops. It was observed during field visits that those who diversify and cultivate their land most intensively are small farmers. They diversify their cropping pattern mainly to minimize risk and satisfy their consumption needs. Since most farmers in Bangladesh are small, diversification has been promoted over the years due to pressing needs of the farmers. This can be further promoted by providing special extension services, supply of quality seeds and other inputs, and credit support to the small farmers. Moreover, the distribution of Khas (government owned) land to landless people may be made conditional to the production of CGPRT/secondary crops.

Figure 5.1 Intensity of cropping (per cent) in Bangladesh



5.3 Diversification of consumption

Diversification of agriculture may be promoted through diversification of food consumption. The consumption pattern of Bangladeshi people was examined from estimates given by household expenditure surveys through the nineties. The data has been summarized and presented in Table 5.3. It appears that considerable diversification has taken place in human consumption during the last decade. The share of rice and wheat in the total food basket has declined, while the share of potato and pulses has increased. This may lead to further diversification of crop agriculture in future if there are enough incentives to cultivate non-cereal crops. Currently potato growers are expanding production through an increase in area and yield mainly due to breakthroughs in technology. It indicates that there is a need to introduce

appropriate technologies and create suitable institutions and infrastructure to accelerate the pace of diversification.

Recent market liberalization could have had a positive impact on diversification through the promotion of exports and increases in prices of CGPRT crop products. But in the absence of appropriate processing techniques and value addition facilities that did not happen. Table A.7 shows that prices of all CGPRT crop products declined in the world market and the magnitude of decline in real prices (in US dollar) was higher in Bangladesh. In the case of sweet potato, however, real prices showed an upward trend, but the area under this crop declined. The evidence suggests that a sort of domestic market adjustment may be required to support diversification. Moreover, appropriate measures would be needed to avail opportunities of diverse agriculture in several directions: geographically (increasing the magnitude of intensive cultivation in areas suitable for CGPRT crop production), horizontally (increasing the spread of CGPRT crop cultivation), and vertically (increasing agro-processing opportunities for value addition). Besides, a marketing network has to be established at home and abroad for increasing the demand for consumption of CGPRT crop products, which will ultimately encourage their domestic production.

Table 5.3 Average per capita daily intake of major food items (in grams)

Food item	1991-1992			1995-1996			2000		
	National	Rural	Urban	National	Rural	Urban	National	Rural	Urban
Rice	472.8	481.6	416.0	464.3	479.0	390.3	458.54	478.84	372.66
Wheat	36.3	34.6	47.1	33.7	32.4	40.1	17.24	14.00	30.12
Potato	43.7	41.4	58.3	49.5	46.7	64.4	55.45	54.71	58.38
Pulses	17.9	17.3	21.7	13.9	12.9	19.4	15.77	14.97	19.04
Vegetables	137.4	135.3	150.9	152.5	154.4	142.9	140.47	141.11	137.92
Edible oil	10.1	9.0	16.4	9.8	8.4	17.0	12.82	11.24	19.11
Onion	11.9	11.2	17.0	11.6	9.9	20.2	15.41	14.08	20.72
Beef	5.2	4.5	9.9	6.6	4.9	15.0	8.30	6.87	13.98
Mutton	0.9	0.8	1.3	1.0	0.8	1.6	0.49	0.43	0.71
Chick-duck	2.0	1.9	3.1	4.0	3.4	7.5	4.50	3.52	8.41
Eggs	4.7	4.6	5.8	3.2	2.6	5.9	5.27	4.61	7.89
Fish	34.5	32.5	47.8	43.8	42.2	51.7	38.45	37.83	40.89
Milk	19.1	18.5	23.2	32.3	30.3	42.1	29.71	28.99	32.59
Fruits	16.9	15.9	23.4	27.6	25.3	39.8	28.35	26.53	35.63
Sugar/gur	8.8	8.5	10.8	9.2	9.1	10.1	6.85	6.37	8.78
Others	64.0	60.5	85.7	50.9	48.2	64.6	55.44	54.58	54.86
Total	**886.2**	**878.1**	**938.4**	**913.9**	**910.5**	**932.6**	**920.06**	**898.68**	**861.69**

Source: Household Income and Expenditure Survey 2000 (BBS, 2003).

5.4 Crop diversification project

Due to the priority given to the production of food-grain crops, particularly rice, the acreage and production of non-cereal crops declined in the 1970s and 1980s. It was then felt necessary to give special attention to some selected non-cereal crops, such as tubers, pulses and oils for diversified consumption as well as import substitution. Consequently, a crop diversification project (CDP) was undertaken jointly by the Government of Bangladesh and the Ministry of Development Cooperation of the Government of Netherlands, and the Canadian International Development Agency (CIDA) in 1989. The project had three implementing agencies namely, Department of Agricultural Extension (DAE), Department of Agricultural Marketing (DAM) and Bangladesh Agricultural Research Institute (BARI). The crops included in the programme were:

Tubers : potato, sweet potato, aroid;
Oilseeds : mustard and rapeseed, groundnut, sesame, sunflower, soybean;
Pulses : lentil, black gram, mungbean, chickpea, field pea, cowpea and pigeonpea.

The effect of CDP on the production of some minor crops was positive. There was a modest increase in potato production, which was attributed to growth in acreage and yield. The yields of pulses and oilseeds have also increased mainly due to the adoption of improved production practices. These crops gave significantly higher yields in 130 CDP upazelas (upazelas or sub-districts are at the middle of the local government administrative chain. For the convenience of administration the country is divided into six administrative divisions. Each division is further sub-divided into zelas (districts). The zela is divided in a number of upazelas (sub-districts) (Alam, 2004) than their national average yield. Nevertheless, the growth in total production of these crops remained insignificant due to limited extension of these crops and a decline in acreage. The work of the project is still in progress under the financial assistance of the government.

5.5 Public policies on diversification

The Government of Bangladesh has been encouraging diversification of agriculture in recent years. The Ministry of Agriculture in its agricultural policy document (GOB, 1999) stated that the crop production system dominated by rice is neither scientific nor acceptable from an economic point of view. The Ministry of Agriculture, therefore, emphasized the necessity of increasing the cultivation and production of other crops. Government policies in this respect include increasing the area and production of potato, sweet potato, pulses, maize and millets (GOB, 1998). Moreover, public sector procurement of maize has been introduced in order to encourage farmers in rice cultivation.

The Fifth Five Year Plan (1997-2002) has categorically mentioned the desire of the government to introduce diversified cropping systems in order to free upland areas in the winter season for non-rice crops. The *Plan* envisaged crop rotation of shallow rooted crops with deep-rooted ones and legumes followed by non-legumes to enrich and maintain soil fertility. Besides, the *Plan* intended to promote diversification of cropping patterns to enhance farmers' income and to help maintain better soil structure for long-term sustainability.

In spite of policy support and constant encouragement from the government for diversification, the index of diversification appears to have remained low over the years. Lack of technological advancement is the main constraint to the diversification of crops. In order to accelerate technological progress, the genetic upgrading of minor crops and the development of HYVs are urgently required for higher productivity in the near future.

5.6 Concluding summary

Diversification of agriculture is sought to minimize risk, stabilize income, change food habits, increase protein intake, promote exports, substitute imports, create employment opportunities and alleviate poverty. In Bangladesh, diversification of agriculture has been promoted slowly over time. As a result, diversification of food consumption has also been promoted. There is a need to expand appropriate processing techniques and value addition facilities to further promote the pace of diversification of consumption in future. It is also necessary to introduce new production technologies and create suitable institutions and infrastructure to accelerate the pace of diversification of products in the country.

6. Yield, Profitability and Comparative Advantage

6.1 Introduction

This section examines the yield rates, profitability and comparative advantage indicators of CGPRT crops. Detailed costs of production, processing and marketing budgets were prepared for each crop separately. Returns from products and by-products were calculated at farm gate price. Financial and economic profitability, nominal and effective protection, and domestic resource costs were calculated for each crop using input-output coefficients obtained from survey data conducted in 2003.

6.2 Yield

The success of crop cultivation depends on crop yield. The average yield of CGPRT crops on sample plots is shown in Table 6.1. Farmers in the study areas have long experience in producing one or other CGPRT crops and the yield rates they obtained were higher than the national average (Table A.8). However, the yield rates obtained from our survey very closely correspond to results of other studies conducted in recent years. The difference is little larger in the case of lentil due to wide divergence in study areas.

Farm gate prices for different CGPRT crops are presented in Table 6.1. These are the prices farmers actually received for their products. Most farmers sell their surplus during the harvest time and the average prices for 2002-2003 determined by this survey were very close to national average harvest time prices.

Table 6.1 Financial and economic returns of CGPRT crops in Bangladesh

Crop	Yield per hectare (kg)	Farm gate price (taka per kg)	Financial return per hectare (taka)		Economic return per hectare (taka)	
			Over full cost	Over variable cost	Over full cost	Over variable cost
Maize	5,738	6.77	13,535	18,591	9,709	14,765
			(1.49)	(1.80)		
Cheena	1,721	6.55	3,991	7,825	4,480	7,568
			(1.55)	(2.69)		
Kaon	1,525	6.95	3,415	6,409	4,478	7,472
			(1.47)	(2.53)		
Potato	26,966	5.12	56,011	71,008	56,118	71,115
			(1.68)	(2.06)		
Sweet potato	12,868	3.34	14,062	19,114	19,586	24,639
			(1.51)	(1.86)		
Lentil	932	24.55	4,901	13,284	5,648	14,031
			(1.27)	(2.34)		
Mungbean	1,189	23.75	9,445	15,641	11,248	17,444
			(1.55)	(2.53)		

Source: Field survey.
Note: Bracketed figures are benefit cost ratios.

6.3 Financial and economic returns

This study examines both financial and economic returns over variable and full costs. Variable costs include all cost items like cost of labour, draught power, irrigation, seeds, organic manures and chemical fertilizers, insecticides and pesticides, etc. used in the process of cultivation and production at market prices. Both cash expenses and imputed value of family owned inputs used in the survey plots were included in calculating the cost of production. The rental value of land at market rates and the depreciation on farm implements were added in the case of full cost calculation. Financial returns over full and variable costs were determined by deducting respective cost items from gross returns (value of products and by-products). In the case of economic returns, all taxes and subsidies were eliminated and wages for human labour were adjusted downward by 0.71 to reflect the opportunity cost of family labour (World Bank, 1992).

Analysis on financial returns shows moderate returns per unit of land for each crop (Table 6.1). Economic returns exceeded financial returns where the cost of tradable inputs was low and that of non-tradable inputs dominated the total cost. On average, CGPRT crops used lesser inputs per unit of land than the other major crops (Table A.9) and generated satisfactory returns over full and variable costs. The returns were high for potato, maize and pulses mainly due to the adoption of new techniques of production. On the other hand, returns were low for millets due to the non-adoption of improved cultivation practices. The observed yield rate was reasonably high for sweet potato even under traditional systems of production and farmers derived substantial profit out of potato cultivation.

6.4 Financial incentives

The impact of public policy on the financial incentives for the production of CGPRT crops was examined by calculating Nominal Protection Co-efficient (NPC), Nominal Rate of Protection (NRP), Effective Protection Co-efficient (EPC) and Effective Rate of Protection (ERP). Reference prices for each crop were based upon f.o.b. world price at the port of a significant exporting country for the commodity. These prices were brought to the import parity level assuming that imports compete with domestic production at the producer level.

Commodity prices at each level in the commodity market were based on observation. In cases where the price at a specific location was unknown, it was derived from a known price by adding or subtracting an assumed margin. Where possible, an average of monthly prices during the principal sales period was used.

Information on marketing costs and margins was collated from field visits and from earlier studies of marketing margins. Where possible these costs were confirmed by interviews with truckers, millers, wholesalers, and retail traders.

NPC is the simplest indicator of price distortion, which is expressed as:

$$NPC = \frac{P_i^d}{P^b_i}.$$

Here P_i^d is the domestic producer price of the commodity i and P_i^b is the border price of that commodity at import parity level. This was also measured in the form of NRP, which was denoted as $NRP_i = NPC_i - 1$. A nominal protection co-efficient (NPC) of greater than 1 indicates that the public sector has protected domestic production by raising its financial price in the domestic market above its economic price.

Data presented in Table 6.2 shows that NPCs were less than 1 and NPRs were negative for all CGPRT crops. The level of protection declined during the 1990s and after due to the withdrawal of input subsidies, output support and import liberalization.

Table 6.2 Comparative advantage in producing CGPRT crops in Bangladesh

Crop/Year	NPC	NRP	EPC	ERP	DRC
Maize					
1970s	0.852	-0.148	0.986	-0.014	0.591
1980s	0.888	-0.112	0.940	-0.060	0.643
1990s and after	0.773	-0.227	0.802	-0.198	0.639
1974-2001	0.836	-0.164	0.90	-0.10	0.628
Millets					
1970s	0.960	-0.040	0.995	-0.005	0.590
1980s	0.860	-0.140	0.868	-0.132	0.526
1990s and after	0.600	-0.400	0.604	-0.396	0.491
1974-2001	0.783	-0.217	0.796	-0.204	0.529
Lentil					
1970s	0.642	-0.357	0.657	-0.343	0.629
1980s	1.018	0.018	1.035	0.035	0.835
1990s and after	0.650	-0.350	0.647	-0.353	0.615
1974-2001	0.784	-0.216	0.793	-0.207	0.700
Potato					
1970s	0.475	-0.525	0.470	-0.530	0.204
1980s	0.370	-0.630	0.354	-0.646	0.189
1990s and after	0.254	-0.746	0.232	-0.768	0.147
1974-2001	0.351	-0.649	0.226	-0.774	0.177

Source: Own estimate.
Note: NRPs can be expressed in percentage terms.

Results obtained from calculating NPCs were reexamined by working out EPCs. Corden's (1957) method was used for calculating EPCs. This was denoted as:

$$EPC = \frac{P_i^d - \Sigma\, a_{ij}\, P_j^d}{P_i^b - \Sigma\, a_{ij}\, P_j^b}$$

Where, P_i^d is the domestic price of the i^{th} commodity, P_i^b is the border price of that commodity and a_{ij} are the technical co-efficients measuring the number of units of traded inputs j per unit of production of output i, P_j^d is the domestic price of traded inputs j, P_j^b is the border price of traded inputs j. The study also measured this indicator in the form of effective rate of protection (ERP) which is expressed as $ERP_i = EPC_i - 1$ (Huda and Talukder, 2000).

Table 6.2 shows that average EPCs were less than 1 and ERPs were negative for all crops, except lentil in the 1980s. This implies that the domestic market for CGPRT crops was not protected and recent increases in production for some of the CGPRT crops was not the result of any protection. Domestic production of maize and pulses may require substantial protection in future for import substitution.

6.5 Comparative advantage

A measure of comparative advantage was used to examine the efficiency of using resources to produce CGPRT crop products at home instead of importing the same from abroad. A country will increase production of a particular product if it can be produced at home at a lower relative cost. The measure is known as domestic resource cost (DRC). This measure equals the cost of domestic resources and non-traded inputs for producing one unit of output less tradable inputs (Burno, 1972). In mathematical notation:

$$DRC = \frac{\sum f_{ij} P_j^d}{Ui - \sum a_{ik} P^b_k}$$

$$(j = 1\text{---}m, \quad k = 1\text{----}n)$$

where

f_{ij} = domestic resource and non-traded inputs j used for producing per unit of commodity i

P_j^d = price of non-traded intermediate inputs in domestic currency

Ui = border price of output i

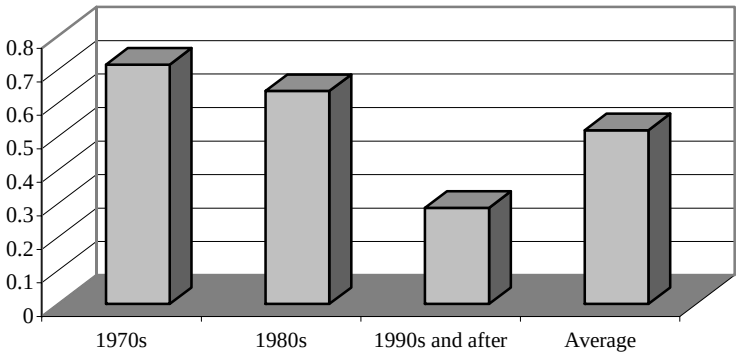
a_{ik} = amount of traded intermediate inputs for unit production of i

P_k^b = border price of traded intermediate inputs (Huda, 2001).

When DRC is less than 1, it would imply that the country will gain from producing more units of the product at home instead of importing from other parts of the world. If the DRC exceeds unity, the opposite would be true.

The DRC values for maize, millets, lentil and potato are presented in Table 6.2. It appears that Bangladesh had comparative advantage in producing CGPRT crops, as DRC values have been less than 1 for the last three decades. The value was positive for potato even at export parity level during the most recent years (Figure 6.1). Results imply that Bangladesh has the potential for export promotion and import substitution through diversification of the crop sector by promoting CGPRT crop production.

Figure 6.1 DRC values of potato at export parity level



6.5.1 DRC for rice and wheat

A comparison of DRC values of CGPRT crops was necessary with those of rice and wheat to determine the relative advantage of producing CGPRT crops over major food grains. For that reason, DRC values of coarse rice (coarse rice is relatively large in grain texture and generally consumed by low income people. Most HYV varieties of paddy produce coarse rice), fine rice and wheat were calculated separately using input co-efficients calculated by Huda (2001) and others in recent years. The time series of those coefficients were extended backwards and forwards using consumer price index.

It appears from Table 6.3 that DRC values were more than 1 for coarse rice over all time periods indicating comparative disadvantage for this major food grain consumed by the majority of the people in Bangladesh. However, DRC values were less than 1 for fine rice and wheat indicating comparative advantage for them. It implies that further expansion of cultivation of

coarse rice at the cost of secondary (CGPRT) crops would be unrealistic from an economic point of view.

Table 6.3 Domestic resource cost (DRC) of rice and wheat

Commodity	DRC over time			
	1970s	1980s	1990s and after	1974-2001
Coarse rice	0.84	1.40	1.56	1.31
Fine rice	0.39	0.41	0.49	0.43
Wheat	0.71	0.77	0.88	0.80

6.5.2 Sensitivity analysis

A sensitivity analysis of DRC was carried out assuming depreciation of the exchange rate by 5 per cent and 10 per cent. Results are presented in Table 6.4. It appears from the table that DRC values for all products reduce with each successive depreciation indicating more comparative advantage of producing CGPRT crops after depreciation. However, the DRC for coarse rice remains greater than 1 for most of the period, even after depreciation, indicating comparative disadvantage for producing a greater quantity of coarse rice in Bangladesh.

Table 6.4 Domestic resource cost (DRC) with depreciation of exchange rate

Commodity	1970s		1980s	
	With 5 % depreciation	With 10 % depreciation	With 5 % depreciation	With 10 % depreciation
Coarse rice	0.80	0.76	1.33	1.26
Fine rice	0.37	0.35	0.39	0.38
Wheat	0.68	0.64	0.73	0.69
Maize	0.56	0.54	0.61	0.58
Millets	0.54	0.56	0.48	0.50
Lentil	0.60	0.57	0.79	0.76
Potato (import) parity	0.19	0.18	0.18	0.17
Potato (export) parity	0.68	0.65	0.61	0.58

	1990s		1974-2001	
	With 5 % depreciation	With 10 % depreciation	With 5 % depreciation	With 10 % depreciation
Coarse rice	1.49	1.42	1.25	1.19
Fine rice	0.46	0.44	0.41	0.39
Wheat	0.85	0.81	0.73	0.71
Maize	0.61	0.58	0.60	0.57
Millets	0.45	0.47	0.48	0.50
Lentil	0.59	0.56	0.67	0.64
Potato (import) parity	0.14	0.13	0.17	0.16
Potato (export) parity	0.27	0.26	0.48	0.46

6.5.3 Alternative approach for estimating DRC

This study used an alternative approach for estimating DRC. This approach provided for measuring the denominator in foreign exchange, i.e. US dollar. Here DRC is expressed in units of domestic currency per dollar. In other words it is a commodity specific exchange rate that has the dimension of local currency per unit of foreign exchange (taka per US$). If the ratio falls below an official exchange rate, the country would save or earn foreign exchange through an investment.

Results of our calculation of DRC values over time through an alternative approach are presented in Table 6.5. It appears that the estimated product specific exchange rates are lower than official exchange rates for all commodities except coarse rice. The evidence indicates that Bangladesh has comparative advantage for producing CGPRT crops, but not for coarse rice, which occupies a major portion of the rice area in Bangladesh.

Table 6.5 Domestic resource cost (DRC) of selected agricultural commodities (in relation to commodity specific exchange rate)

Commodity	Commodity specific exchange rate			
	1970s	1980s	1990s and after	1974-2001
Coarse rice	10.99	39.10	65.21	41.48
Fine rice	5.16	19.40	20.92	13.54
Wheat	9.24	21.05	36.89	23.86
Maize	8.13	9.17	27.05	18.56
Millets	7.78	14.17	20.45	14.84
Lentil	8.72	22.46	26.02	20.22
Potato (import parity)	2.74	4.83	6.23	4.80
Potato (export parity)	8.99	15.13	12.21	12.45
Official exchange rate	**13.31**	**26.79**	**44.33**	**30.79**

6.6 Concluding summary

Financial and economic returns from producing CGPRT crops were examined. Results show that CGPRT crops generated satisfactory returns over variable and full costs. The returns were high for potato, maize and pulses mainly due to the adoption of new techniques of production. The returns were low for millets due to non-adoption of improved cultivation practices. Sweet potato was highly profitable even under traditional systems of production mainly due to higher yields.

A measure of comparative advantage shows that Bangladesh has comparative advantage for producing all CGPRT crops, as DRC values have been less than one for the last three decades. The value was positive for potato even at export parity level during the most recent years. It reveals that the country has enough potential for diversification of crop agriculture through the expansion of secondary crops (CGPRT crops).

7. Marketing of CGPRT Crops

7.1 Introduction

Farmers generally sell their produce at the farm gate or rural assembly markets at a relatively low price. Over 80 per cent of major CGPRT crop products are marketed, while less than 20 per cent are kept for home consumption and seed (Table 7.1). Cheena (Proso millet; *Panicum miliceum L.)* and Kaon (Foxtail millet; *Citera italica*) are grown on poor soil in harsh environments and they are very poor farmers who grow these crops mainly for human consumption. Less than half of the produce of these crops is sold in the market. They preserve seeds from their own produce in a traditional way. In the case of maize, farmers mainly use hybrid seeds, which they purchase from NGOs (the most prominent one is BRAC) and do not keep much local seed for production in the next year.

Table 7.1 Disposal pattern of CGPRT crop products

Crop	Disposal pattern (% of total production)				
	Consume	Sale	Gift	Seed	Total
Maize	0.83	98.31	0.76	0.10	100.00
Cheena	48.80	44.96	1.17	5.07	100.00
Kaon	62.66	32.86	1.24	3.24	100.00
Lentil	8.96	78.40	1.17	11.47	100.00
Mungbean	6.29	87.07	0.66	5.98	100.00
Potato	2.67	89.41	1.60	6.32	100.00
Sweet potato	12.53	82.85	3.21	1.41	100.00

Source: Field survey.

7.2 Marketing cost and margin

In the case of the transfer of commodities from farm gate to consumers several utilities (time, place, form etc.) are created. Intermediate traders incur direct costs for different reasons (transportation, market tools and fees, commission charges, milling costs, storage costs, physical loss etc.). Moreover, the traders, wholesalers and retailers earn profit through the flow of transfer of commodities to consumers. Thus, the total direct cost incurred and the net profit (net marketing margin) earned by transferring a commodity from the farmer to the consumer is said to be the gross marketing margin. The rate of return on capital is calculated by dividing the net marketing margin (profit) by farm gate price plus the direct marketing cost (Alam, 1993).

Marketing costs and margins are important indicators of an efficient marketing system. This section provides information on marketing costs and margins of important agricultural commodities marketed in Bangladesh. All figures on prices, marketing costs and margins for CGPRT crop products were estimated on the basis of field observations in 2003.

Before presentation of the study results regarding marketing costs and margins, an introduction on the marketing channel is necessary. Marketing channels for different commodities are different in Bangladesh. This study investigated marketing channels for CGPRT crops in specific locations and calculated the marketing cost and margin for each crop at every stage. The marketing channels observed for different crops are given below:

Maize

Farmer → Local trader→ *Aratder* (commission agent)/ BRAC → Wholesaler → Consumer

Cheena

Farmer → Local trader → Miller-cum-wholesaler → Retailer → Consumer

Kaon

Farmer → Local trader → Miller-cum-wholesaler → Retailer → Consumer

Lentil

Farmer → Local trader → *Aratder* → Miller-cum-wholesaler → Retailer → Consumer

Mungbean

Farmer → Local trader → *Aratder* → Miller-cum-wholesaler → Retailer → Consumer

Potato

Farmer → Local trader → Cold storage → *Aratder* → Wholesaler → Retailer → Consumer

Sweet potato

Farmer → Local trader/*Aratder* → Wholesaler → Retailer → Consumer

Farm gate prices, aggregated marketing costs and margins, and consumer prices of CGPRT crops are shown in Table 7.2. It can be noticed that the grower's share of consumer's price is well above 60 per cent for maize, millets and pulses. The share is relatively low for potato and sweet potato. These are perishable products and the traders earn high profits but add a risk premium with it. The cold storage system for potato was found to be satisfactory but this system is yet to be developed for sweet potato. Farmers are likely to benefit from a reduction in marketing costs and margins of tubers. There are signs of inefficiencies in the commodity market for perishable CGPRT crops. The rate of return on capital was high for tubers (35 per cent for sweet potato and 27 per cent for potato) but low for pulses and coarse grains.

Table 7.2 Marketing cost and margin of CGPRT crop products in Bangladesh

Crop	Farm gate price (A)	Marketing cost (B)	Trader's profit (C)	Marketing margin (B+C)	Consumer's price D	Return on capital (%) (C/(A+B))
Maize (taka/quintal)	677.00	84.00	189.00	273.00	950.00	24.84
% of consumer price	71.26	8.84	19.89	28.74	100.00	-
Cheena (taka/quintal)	655.00	179.00	166.00	345.00	1,000.00	19.90
% of consumer price	65.50	17.90	16.60	34.50	100.00	-
Kaon (taka/quintal)	695.00	199.00	156.00	455.00	1,050.00	17.45
% of consumer price	66.19	18.95	14.86	33.81	100.00	-
Lentil (taka/quintal)	2,455.00	824.5	690.50	1,515.00	3,970.00	21.06
% of consumer price	61.84	20.77	17.39	38.16	100.00	-
Mungbean (taka/quintal)	2,375.00	575.5	554.50	1,130.00	3,505.00	18.79
% of consumer price	67.76	16.42	15.82	32.24	100.00	-
Potato (taka/quintal)	512.00	230.00	198.00	428.00	940.00	26.68
% of consumer price	54.47	24.47	21.06	45.53	100.00	-
Sweet potato (taka/quintal)	334.00	77.00	145.00	222.00	556.00	35.28
% of consumer price	60.07	13.85	26.08	39.93	100.00	-

Source: Field survey 2003.

7.3 Seasonal price difference

Price differences of various CGPRT crop products during 2002-2003 are presented in Table 7.3. It appears that there was considerable variation of prices depending on the nature of the product. The variation was lower for coarse grains and pulses and higher for tubers. The prices were lower during harvest but higher a few months after the harvest or during the pre-harvest season. The seasonal difference was the highest for sweet potato indicating that a margin is available to those who are able to cold store the commodity.

Table 7.3 Seasonal difference of prices of various CGPRT crop products in the study areas during 2002-2003

Crop	Price in taka per 100 kg				Difference between highest and lowest price (%)
	Harvest price	Four months after harvest	Eight months after harvest	Before harvest	
Maize	677	780	860	950	40.32
Cheena	655	795	980	1,100	67.94
Kaon	695	850	1,000	1,140	64.03
Lentil	2,455	3,712	3,950	3,860	57.23
Mungbean	2,375	3,024	3,368	3,687	55.24
Potato	512	790	920	980	91.41
Sweet potato	334	520	645	680	103.59

Source: Field survey.

The large difference in prices from season to season for potato, sweet potato, cheena and kaon indicate that there is hardly any government control on private traders in determining prices for these commodities. In the case of maize and lentil, however, government policies seem to have favoured price stability in the market. Seasonal differences were less than 60 per cent for maize and pulses.

7.4 Price difference by location

Information was gathered on the harvest prices of selected CGPRT products from at least two locations. The differences in prices of these products between locations are presented in Table 7.4. It reveals that the price difference was below 6 per cent for all commodities. However, a relatively high difference in prices for sweet potato, potato and maize suggests that there is scope to improve the marketing efficiency of these products through better communication and regular price information.

Table 7.4 Price differences between locations for selected CGPRT crop products during the harvest of 2002-2003

Crop	Harvest price (taka)		Price difference (%)
	Location 1	Location 2	
Maize	661 (Lalmonirhat)	693 (Manikgonj)	4.84
Lentil	2,450 (Jhenaidah)	2,460 (Kushtia)	4.08
Mungbean	2,393 (Jhenaidah)	2,357 (Pabna)	1.53
Potato	500 (Rangpur)	524 (Munshiganj)	4.80
Sweet Potato	325 (Noakhali)	343 (Jamalpur)	5.54

Source: Field survey.

7.5 Storage-cum-credit

With an increasing emphasis on diversification, marketing problems are likely to multiply. Currently marketing costs are high because of inadequate infrastructure, and seasonal price differences are high due to a lack of credit and storage facilities. The government can provide improved marketing services to ensure fair returns to growers and adequate supply to consumers at reasonable prices. Such services must include the development of infrastructure,

promotion of agro-processing industries, improvement of storage facilities and provision of credit to small farmers. Recently, the Directorate of Agricultural Marketing (DAM) experimented with a special marketing programme for marginal and small farmers (shogorip) in selected areas of the country. Our observations suggest that this programme has been largely successful in providing storage and credit facilities to the poor growers but needs to be intensified in CGPRT crop growing zones of the country to ensure the stability of prices and sustainability of production at the farm level.

7.6 Price commission

The magnitude of spatial price fluctuation is also high for certain commodities. Better transportation, communication and information systems can help minimize such fluctuations. Feeder roads linking villages with main roads can reduce marketing costs. Moreover, quick transportation of commodities by train, truck and river transports can minimize time and cost. In addition, the announcement of price information at market places can keep growers and traders informed of the latest price situation in different markets and regions. Daily bulletins of price information on agricultural commodities should be published through radio, television and newspapers.

An agricultural price commission should be formed to recommend procurement prices and regularly monitor spatial and temporal price fluctuations of agricultural commodities and suggest interventions. All policies relating to the imposition of taxes and the realization of import duties should be framed in consultation with the price commission. The commission should be an independent organization to work with full autonomy.

7.7 Concluding summary

The marketing efficiency of CGPRT crop products was examined by calculating marketing costs and margins, and seasonal and spatial price fluctuations during the study period. It revealed that there is substantial inefficiency in the marketing of some CGPRT crops. The inefficiency was high for perishable CGPRT products (potato and sweet potato) and low for pulses and coarse grains. There is scope to improve marketing efficiency through the expansion of cold storage facilities, creation of processing establishments, better communication and regular price information.

8. Policy Environment for CGPRT Crops

8.1 Trade liberalization and CGPRT crops

Keynes's interventionism got into problems towards the late 1970s with increased stagnation in output and employment accompanied by high inflation. The oil price shocks in 1972-1973 and in 1979-1980 put the world economy into a severe recession. Finance became the most crucial factor worldwide. Consequently, a wave of economic liberalism provoked reform all over the world.

The green revolution of the 1960s, 1970s and after made a great contribution to increasing food production in developing countries. The high level protection of agriculture in developed countries, including the USA and Western European countries, also stimulated agricultural production. Moreover, as a result of overproduction in some developed countries, international prices of agricultural commodities started to decline. In recognition of this situation, the agricultural exporting countries began to reduce agricultural protection and deregulate production control. They also started negotiations on agricultural trade in the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) to open the market with a view to reboot international food prices and increase trade. In April 1994, an agreement was signed at Marrakesh, Morocco integrating food into the global free commodity market. The principle of the free market economy became applicable to all commodities including agricultural commodities.

8.1.1 Objective

The long-term objective of the agreement on agriculture is to establish a fair and market-oriented agricultural trading system and initiate a reform process through the negotiation of commitments on support and protection. It was thought that substantial progressive reduction of agricultural support and protection should be made over an agreed period of time that would result in the correction and prevention of restrictions and distortion in world agricultural markets.

8.1.2 Commitments

The agenda for liberalization of agriculture consists of three components: market access, domestic support and export competition. The provisions under market access call for reductions of tariff and non-tariff barriers. Under domestic support, countries are required to reduce trade distorting domestic support and under the provision of export competition, countries are committed to reduce the value of export subsidies. Being a least developed country (LDC), Bangladesh is exempt from these reduction commitments.

8.1.3 Market access

The URAoA, under its commitment to market access, called for the conversion of all non-tariff trade barriers into tariff equivalents, a reduction of bound tariffs over time, and setting of low import tariffs for a fixed quota of imports. Under tariffication, member countries were required to convert non-tariff barriers during the base period (1986-88) into tariff equivalents and to establish a base rate of duty for individual commodities covered by the URAoA. The average reduction of tariffs after the tariffication of non-tariff barriers was set at 24 per cent for developing countries and 36 per cent for industrialized countries. Industrialized countries had a time frame of six years within which to decrease their tariff levels while developing countries had 10 years. Minimum access had to be established at not less than 3-5 per cent of domestic

consumption during the base period (1986-1988). As a LDC, Bangladesh was not required to undertake any such commitment but had to bind tariffs on all agricultural products.

Market access reform in Bangladesh began in the early 1980s with a reduction in import duties and was followed by a reduction in quotas in 1985 and a simplification of tariffs in 1986. The most intense period for trade reforms occurred in the 1990s with a movement towards lower tariff rates (Table 8.1).

Table 8.1 Un-weighted average tariff rates for different commodity groups in Bangladesh

(%)

Commodity group	FY92	FY93	FY94	FY95	FY96	FY97
Primary commodity	55.2	47.7	34.9	31.6	24.6	22.3
Intermediate inputs	49.5	41.6	31.8	23.2	20.2	19.6
Capital goods	45.0	38.7	26.2	13.9	12.3	12.5
Final consumer goods	80.3	63.6	49.9	38.6	33.7	32.3
All commodities	57.3	47.4	36.1	25.9	22.3	21.5
Commodity group	FY98	FY99	FY00	FY01	FY02	FY03
Primary commodity	21.9	21.4	17.1	17.7	15.6	14.9
Intermediate inputs	19.2	18.9	15.6	15.7	20.1	21.0
Capital goods	12.1	12.3	16.1	11.3	7.0	8.0
Final consumer goods	30.6	29.0	31.0	29.6	26.0	22.6
All commodities	20.7	20.3	19.5	18.6	17.1	16.4

Source: National Board of Revenue.

In 2002-2003, the un-weighted average tariffs for all agricultural products (primary commodity) declined to 15 per cent from 55 per cent in 1991-1992. In a similar way, the import-weighted average tariff fell to 12 per cent from 23 per cent over the same period. The magnitude of decline in tariff rates for all other commodities showed almost the same trend (Table 8.2).

The reduction of tariff rates for CGPRT crops, particularly potato and pulses, was quite significant (Table A.10). Under the minimum access level provision, the current access opportunity is more than the threshold for all commodities, with the exceptions of potato and sugar.

Table 8.2 Import-weighted average tariff rates for different commodity groups in Bangladesh

Commodity group	FY92	FY93	FY94	FY95	FY96	FY97
Primary commodity	23.4	23.2	27.2	17.3	13.2	16.3
Intermediate inputs	24.1	23.7	22.9	26.3	22.7	22.2
Capital goods	18.7	18.5	16.2	12.5	9.5	10.4
Final consumer goods	47.3	36.5	36.7	26.5	24.1	23.1
All commodities	24.1	23.6	24.1	20.8	17.0	18.0
Commodity group	FY98	FY99	FY00	FY01	FY02	FY03
Primary commodity	13.6	9.5	13.6	14.9	9.4	12.0
Intermediate inputs	21.3	21.3	15.1	15.0	16.2	15.8
Capital goods	8.2	8.1	9.9	10.4	3.3	7.7
Final consumer goods	20.1	17.6	16.5	20.3	14.0	11.9
All commodities	16.0	14.1	13.8	15.1	9.7	12.4

Source: National Board of Revenue.

8.1.4 Domestic support

The Uruguay Round Agreement on Agriculture (URAoA) under its domestic support policies did not include expenditure on research, extension, disease control, food security, and rural development etc. (green box measures) in reduction commitments. Nevertheless, subsidies on inputs and price support for outputs were categorized under trade distorting policies and were required to be kept within the limit of 5 per cent of the value of output for the developed countries and 10 per cent for the developing countries. The total aggregate measure of support

(AMS) was to be reduced by 20 per cent for developed countries and 13.3 per cent for developing countries (with no reduction for LDCs) over the implementation period.

Bangladesh provides support to agricultural research, extension, training, marketing and infrastructure that are nondistortionary in character. These supports fall under the green box area and are excluded from AMS reduction commitments. During the 1970s and early 1980s agricultural inputs were heavily subsidized and price support for agricultural output was also significant. These subsidies and support were gradually reduced and became quite insignificant during the 1990s. Table 8.3 shows that Bangladesh did not provide any price support to any of the agricultural commodities after the 1995-1996 financial year. Subsidies on fertilizer and irrigation accounted for 2.53 per cent of the value of unassisted output in 1988-1989, which declined gradually to less than one-tenth of one per cent in 1998-1999. The calculated producer subsidy equivalent (PSE) slightly increased over the first three years of the new millennium, but still it hovers around a half of only one per cent, very insignificant in comparison with that of about 40 per cent for the European Union and 35 per cent for OECD countries (Alam, 2004). Under such circumstances, CGPRT crops in Bangladesh did not receive any significant product specific support that could encourage production.

Table 8.3 Producer subsidy equivalent (PSE) in Bangladesh

Year	Input subsidy (% of unassisted output)	Price support (% of unassisted output)	Total subsidy (PSE)
1988-1989	2.53	0.20	2.73
1995-1996	0.83	0.01	0.84
1996-1997	0.62	0	0.62
1997-1998	0.43	0	0.43
1998-1999	0.08	0	0.08
1999-2000	0.21	0	0.21
2000-2001	0.24	0	0.24
2001-2002	0.48	0	0.48
2002-2003	0.45	0.	0.45

8.1.5 Export subsidies

Under the commitment on export subsidies members were required to reduce the value of mainly direct export subsidies to a level 36 per cent below the 1986-1990 base period level over the six-year implementation period, and the quantity of subsidized exports by 21 per cent over the same period. In the case of developing countries, the reductions were two-thirds of those of developed countries over a ten-year period and subject to certain conditions. There were no commitments on reducing the costs of marketing of agricultural exports or internal transport and freight charges on export shipments. LDCs were not obliged to reduce export subsidies but were required to freeze such subsidies at the 1986-1990 period levels.

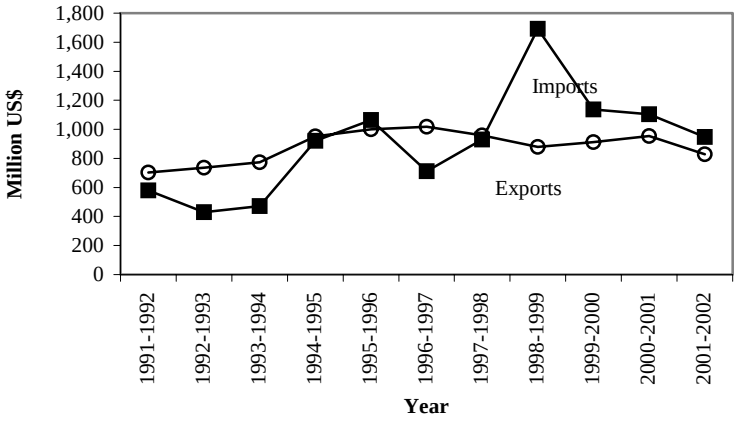
Bangladesh declared no export subsidies in her schedule of UR commitments. However, there may be some elements of subsidies enjoyed by the country's export sector. They include a low rate of direct subsidy on the export of vegetables, export subsidies in the form of lower interest rates than market interest rates, tariff concessions on imports of capital machinery, and some sort of subsidy on export credit guarantee schemes. Most CGPRT crop products are non-exportable items and they are unlikely to benefit from these subsidy elements. Only potato growers have the potential to enter into the export market and are expected to be encouraged through these subsidies.

8.1.6 Impact

It was interesting to note what has happened to Bangladesh's economy after adhering to WTO rules on the liberalization of trade in agriculture. Firstly, the agricultural export and import situation of Bangladesh over the last eleven years (1991-1992 to 2001-2002) was examined. It was observed that total agricultural exports increased by about 2 per cent and

agricultural imports increased by 9 per cent per year over the said period (Table A.11 and A.12). Figure 8.1 shows that agricultural imports superseded the export figure in 1995-1996 and hence, the import curve continued to be above the export curve for the remainder of the time period. Shortages of CGPRT crop products have contributed significantly to an increase in overall demand for agricultural imports.

Figure 8.1 Agricultural exports and imports



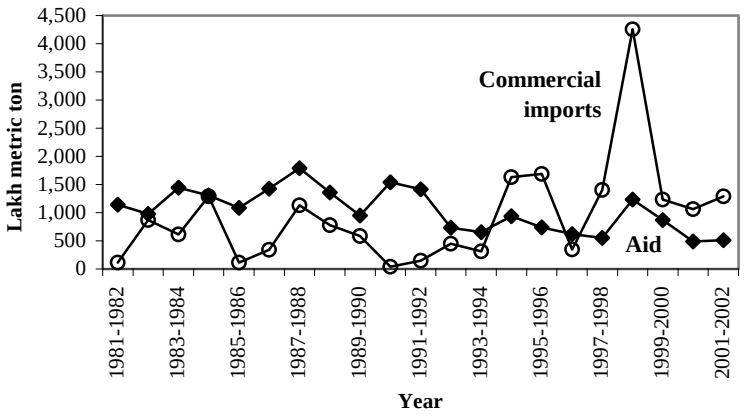
The total export earnings of the country increased by 11.9 per cent, while import expenditure increased by 9.59 per cent over the last 11 years. It should be mentioned that most export earnings in Bangladesh come from the garment industry, where the bulk of export earnings goes back out of the country to pay for imported raw materials and machinery.

The average annual growth rate of export earnings was negative for jute, jute products, tea and total crops. However, the annual growth rate of exports from the agricultural sector was positive mainly due to high export earnings from frozen food, and hides and skins. The growth rates of imports for all agricultural commodities were positive except for wheat, and were very strong for pulses, maize, edible oil and raw cotton. The situation is unlikely to change unless duty-free and quota-free access of Bangladeshi products are ensured to developed countries.

The WTO member countries attending ministerial meetings recognized the special difficulties faced by LDCs and called for providing more technical assistance to LDCs for trade development. They also appealed for enhancing the magnitude of food aid and concessional loans to LDCs for their adjustment to a new global situation. Bangladesh, as a LDC, was supposed to be a beneficiary of this assistance. However, the country has not benefited much from such benevolent aid and assistance commitments in recent years.

Data presented in Table A.13 shows that the annual growth rate of foreign assistance has declined by 1.7 per cent over the last eleven years. The amount of foreign loans has slightly increased but the amount of donations significantly dropped during the period of liberalization. The proposition was further examined from imports of food grains. It appears from Table A.14 that total imports increased over the last decade but Figure 8.2 shows that commercial imports crossed the line of food aid in 1994-1995, reached their peak in 1998-1999, and remained above the line of food aid up until the last year of observation. The evidence confirms the view that Bangladesh had to face more loss than it enjoyed gains from the eventualities of recent trade liberalization.

Figure 8.2 Food grains imported through commercial imports and aid

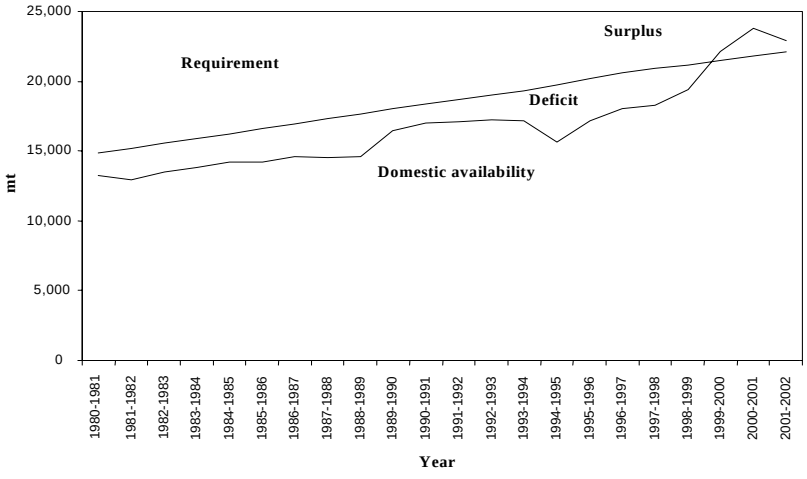


The impact of trade liberalization and reform was not very positive on macro-economic performance. The growth rate of GDP stagnated at around 5 per cent and the overall budget deficit did not show any sign of improvement. The amount of foreign exchange reserve increased in absolute terms but declined in relative terms (Table A.4). The rate of inflation has, however, declined over the years.

8.2 Food self-sufficiency and CGPRT crops

The Government of Bangladesh is committed to achieve self-sufficiency in food production. To that effect the farmers, agricultural scientists and policy makers have been working hard for years together. Very recently the country produced a small surplus of food grains (Figure 8.3), but there is still a huge deficit in the production of other crops. The deficit is much larger for CGPRT crops, particularly for maize and pulses, which has increased over time with the increases in the population. It is possible to create a significant increase in the production of these crops provided new technologies are generated and policies are framed conducive to technology adoption.

Figure 8.3 Food grain availability ('000 mt) from domestic production, deficit and surplus



Bangladesh has already phased out direct subsidies on inputs and outputs. Product specific support to CGPRT crops is almost negligible. However, there is a project to promote the production of maize in the Directorate of Agricultural Extension and another project has recently been launched by BARC to promote the production of pulses. These are likely to generate new technologies, encourage transfer of technologies to the farmer's field and increase the production of these crops in the near future.

Research on the generation of field augmenting technologies has progressed satisfactorily in the country over the last three decades. A number of improved varieties of seeds have been developed by the scientists of BARI in recent years. They include 11 varieties of maize, one variety of cheena, three varieties of kaon, four varieties of barley, four varieties of lentil, eight varieties of gram, two varieties of lathyrus, five varieties of mungbean, three varieties of black gram, two varieties of cowpea, 18 varieties of potato and five varieties of sweet potato. The maximum potential yield (Table A.15) demonstrated by these varieties in the farmers' field is much higher than the national average yield (Table A.8).

Nevertheless, these varieties have not yet been sufficiently transferred to the farmers' fields. In the case of potato and maize, improved varieties cover over 80 per cent of the cropped land in the study areas. In the case of lentil and mungbean, the coverage of improved varieties is low; a little over 40 per cent. No farmer in the study areas reported to have cultivated improved varieties for cheena, kaon and sweet potato. Many farmers were not aware of the existence of improved varieties of these crops. They need more attention of the researchers, extension workers and policy makers to become attractive to the producers and consumers. The collection and preservation of germplasm of these crops (local varieties) is urgently required to save them from the threat of possible extinction. At the same time, improved varieties of these crops should be distributed to the farmers through BADC and other agencies.

8.3 Concluding summary

Bangladesh has liberalized its economy through the reduction of tariff rates and the withdrawal of agricultural subsidies although the country, as a least developed one, was exempted from reduction commitments. The un-weighted average tariff rate for all agricultural products declined to 15 per cent in 2002-2003 from 55 per cent in 1991-1992. Subsidies on irrigation and fertilizer declined from 2.53 per cent of the value of unassisted output in 1988-1989 to 0.45 per cent in 2002-2003. Moreover, there is a very low rate of subsidies on agricultural exports. However, the impacts of trade liberalization policies were not favourable on the agricultural economy of Bangladesh. Total agricultural exports increased by about 2 per cent but agricultural imports increased by 9 per cent per year in the 1990s. Imports of maize and pulses increased significantly over that period. Besides, commercial imports of food grains increased and the magnitude of food aid dropped over the same period. This reveals that Bangladesh had to face more loss than it enjoyed gains from the eventualities of recent trade liberalization. In view of the above circumstances, more investment on yield increasing technology generation and adoption is necessary to meet the current food deficit and accelerate the speed of diversity in agriculture. Collection and preservation of germplasm of some of the CGPRT crops is urgently required to save them from the threat of possible extinction.

9. Agricultural Diversification and Poverty Alleviation

9.1 Overview of poverty alleviation public policies

Bangladesh is a very poor country with low per capita income. About 50 per cent of the population live below the poverty line. Most of them suffer from chronic malnutrition. They consume less food than what is needed because they do not have the purchasing power to buy necessary food items. CGPRT crop products are less expensive than major food items and even the poorest of the rural poor have access to coarse grains, pulses and tubers. Thus these crops play a vital role in lessening the burden of poverty and malnutrition in rural Bangladesh.

Poverty alleviation is the over-riding objective of the Fifth Five Year Plan of Bangladesh. The government has recently drafted a poverty reduction strategy paper (PRSP) in which priority is given to development of the rural areas where most of the poor people live. It has been envisaged that rapid agricultural growth will help sustain overall economic growth with better capacity to reduce unemployment and poverty (GOB, 2003a). The expansion of CGPRT crops will promote the diversification of the rural economy, raise income and wages, and enable the supply of low-cost food to improve the nutritional status and food security of the people. Thus growth in the production of minor cereals, pulses and tubers will ensure a reduction in poverty.

An accelerated poverty reduction strategy for Bangladesh should focus on a pro-poor orientation of the growth process. Priority areas for intervention include farm and non-farm economic activities, small and medium manufacturing enterprises, development of infrastructure, skill training and awareness building. Rural growth strategy should be driven by crop diversification, non-crop agricultural expansion and enhanced non-farm production. CGPRT crops can play a vital role in each area creating employment and income opportunities for poor people and reducing the burden of poverty in rural areas.

9.2 Potential benefits of agricultural diversification for poverty alleviation

CGPRT crops are cultivated by relatively poor farmers who generally only own a small piece of farmland (Table A.16). They cultivate these crops on poor soil in a harsh environment. These crops require less care, less inputs and less intercultural operations that make them suitable for the poor producers. But due to an increase in area under irrigation and fine HYV grains, CGPRT crops have shifted to more marginal and less productive land. Results of this study show, however, that returns of these crops are still attractive and farmers can make more money with less investment by producing CGPRT crops. Thus expanded production of these crops through intensive and extensive cultivation is likely to increase farmers income and reduce the incidence of poverty in rural Bangladesh.

Although consumption of CGPRT crop products is mainly associated with poverty, they have an important nutritional significance. For example, maize has a higher nutritional value than rice in terms of protein, fat and minerals. Also millet has a higher value in terms of protein, fat, minerals and fibre content than that of rice. Pulses contain about twice as much protein as cereals. They also contain amino acid lysine, which is generally deficient in food grains. Thus the consumption of CGPRT crop products can help reduce the magnitude of malnutrition in the country.

In order to meet the demand for the increasing number of livestock and their higher productivity, feed resources have to be augmented. Pulses and coarse grains play a vital role in providing fodder for farm animals. After de-husking pulses and coarse grains, bran is also used as quality feeds for animals. Thus increased production of CGPRT crops can play a vital role in providing balanced nutrition to livestock and poultry to ensure higher productivity, which is very necessary for enhancing the health and nutritional status of people.

CGPRT crops create employment for rural poor in the production process, industrial utilization and agribusinesses. Many female workers are involved in processing CGPRT products creating employment for them. Thus CGPRT crops can generate income for both sexes through the creation of more job opportunities and the low cost of production.

9.3 Redirection of public policies relating to poverty alleviation

The magnitude of poverty in Bangladesh has been declining at a very slow rate. An important reason is the slow growth rate of the rural economy. This was due to a steady decline of public expenditure on agriculture (as a percentage of total development expenditure) in the 1980s and 1990s. The premature shift of resources from agriculture to other sectors created a dampening effect on the rural farm and non-farm economy resulting in only a slow reduction of poverty. In view of achieving the Millennium Development Goals, there is a need to redirect public policies and increase investment in agriculture. The budget speech (2004-2005) of the Finance Minister of Bangladesh has categorically emphasized the need for higher investment in agriculture and indicated several policies and measures to boost agricultural production. The most significant ones are as follows:

- Programmes related to agricultural research, extension, production of improved varieties of agricultural seeds, irrigation, fertilizer, supply of quality seeds and crop diversification will be further expanded to boost agricultural production.
- Steps will be taken to ensure fair prices of agricultural commodities and to increase agricultural subsidies. Other special incentive programmes for agriculture will be further extended.
- Credit at a lower rate of interest and technical know-how for agriculture, fisheries and livestock and rural non-farm activities will be further extended.
- Credit without collateral at a lower rate of interest for developing micro-enterprises will be assured.

Bangladesh has the constitutional obligation to meet the basic needs of all people in the country. Poverty is related to a lack of basic needs. The government plans to ensure the provision of basic needs to every citizen within the shortest possible time. For that purpose a pro-poor growth strategy has been emphasized. Promotion of CGPRT crops will help considerably to achieve this objective. This will require higher investment and technological advancement in the CGPRT crop sector, which is still lacking in the country.

Higher growth in the CGPRT crop sector will promote growth in the non-farm sector through an increase in processing activities and agribusinesses. Access to non-farm income is critical for poor people in raising their household income. This can also serve as an important safety net during post-disaster periods, which are characterized by large-scale damage to crop agriculture and loss of agricultural wage employment. However, productivity growth in the non-farm sector requires some degree of upscaling with improved technology and marketing support. This will also require skill development, better road and communication networks and access to credit. A concerted effort is necessary to ensure these facilities for the alleviation of poverty in the country.

An objective of agricultural development is to achieve nutritional self-sufficiency through crop diversification. This can be realized by imparting training for the creation of

nutritional awareness at the farm family level to change food habits and create effective demand for nutrient-rich food items. This will increase balanced production and consumption of nutrient-rich cereals and pulses in order to ensure food and nutritional security at the household level. This will also encourage the processing and preservation of CGPRT products and other value adding activities at a household level to ensure gender equity and the empowerment of women.

The development of infrastructures and marketing linkages are necessary to promote CGPRT crop product based industries for both the domestic economy and export markets. In this case, a set of pro-active policies are required for developing trade related infrastructure and the removal of non-trade barriers. This will necessitate regional cooperation for greater trade opportunities, job creation and poverty alleviation.

The need for target-oriented programmes to enhance the quality of life of poor people through diversification of the agricultural economy has become a greater urgency in Bangladesh. A disappointing aspect is that there has been a considerable lack of coordination of development activities including the delivery of micro-credit among various government agencies, NGOs, CBOs (Community Based Organizations) and CSOs (Civil Society Organizations) leading to a duplication of efforts, waste of resources and lack of synergy. There is a need for greater coordination among them to make anti-poverty programmes successful at the grassroots.

9.4 Concluding summary

Bangladesh is a very poor country with low per capita income. About 50 per cent of the population live below the poverty line and most of them suffer from chronic malnutrition. The expansion of CGPRT crops will promote diversification of the rural economy, stimulate growth in the non-farm sector, raise income and wages of the people and enable the supply of low-cost food to improve the nutritional status and food security of the poor. Thus expanding production of these crops is likely to reduce the incidence of poverty in the country. To achieve this goal, target-oriented programmes to enhance the quality of life of poor people through diversification of agriculture is necessary. Besides, training for the creation of nutritional awareness and effective demand for nutrition-rich CGPRT products at the farm family level is also necessary. Moreover, delivery of micro-credit, development of infrastructures and the establishment of marketing linkages are required to promote CGPRT crop product based industries in the country.

10. Demand for CGPRT Crops and their Industrial Importance

10.1 Farmers perception of demand

During field visits, farmers were asked to give their opinion about the future of CGPRT crops. Their reactions were mixed. Over 45 per cent of the farmers opined that the cultivation of CGPRT crops will increase in future because they are substantially profitable with less effort and little cash requirement. About 20 per cent of them said that the situation will remain unchanged and others put forward a rather negative opinion. Those who opined against the possibility of expanding CGPRT crop cultivation argued that with the expansion of irrigation facilities and adoption of new technologies farmers will produce more rice. Moreover, an increase in income in future will lead to a decline in demand for their consumption. Therefore, people will reduce the area under CGPRT crops. Some of the farmers were pessimistic about millets because their per unit yield is low and improved varieties developed by BARI are yet to be adopted by farmers in the field. The prices of millets are also very low and there is less incentive to produce these crops.

10.2 Income elasticities of demand for CGPRT crops

Using Household Expenditure Survey data from 2000, income elasticities of demand for products from CGPRT crops have been estimated. Overall income elasticity of demand for these products was less than one, in some cases it was very low, and in one case it was even negative. The estimates of income elasticity of demand for pulses and tubers were 0.42 and 0.23 respectively, and the estimate for maize, barley and millets together was 0.62. The elasticities were high for lentil (0.89) and mungbean (0.98), low for gram (0.04) and negative for lathyrus (-0.26).

The elasticities are quite low for cereals (Table 10.1). With the achievement of self-sufficiency in rice production in recent years, the elasticities for rice and wheat have declined. These are likely to decline further towards the end of this decade. But the elasticities for other cereals, such as maize and millets are likely to increase slightly with the creation of facilities for value addition and the development of livestock and food processing industries in the country.

Projections for 2010 are based on the growth rate of the population, economic growth and income elasticity of demand. For population estimates, an inter-census growth rate of 1.5 per cent per annum between 1991 and 2001 as the base was used, then declining to 1.4 per cent in 2005 and further to 1.3 per cent in 2010. The aggregate per capita annual income growth was about 3.5 per cent for the ten years ending in June 2000. This growth rate is likely to continue through 2005 and will increase at 4 per cent thereafter. Under such a situation, the required growth rate in the production of maize and millets by 2010 would be 3.65 per cent, the highest among cereals. Recent growth records for maize are quite impressive, but very disappointing for millets.

Table 10.1 Income elasticities of demand for CGPRT crops and required growth rates in production to meet the domestic demand

Crops	Income elasticities		Required growth rates (%)		Recent growth rates (%)
	2000 (Actual)	2010 (Projected)	2001-2005	2006-2010	
All cereals	0.08	0.04	1.68	1.46	2.70
Rice	0.04	0.02	1.41	1.38	3.63
Wheat	0.71	0.35	3.88	2.70	5.65
Other cereals (maize and millets)	0.62	0.65	3.57	3.65	-0.93
All pulses	0.42	0.31	2.87	2.54	-3.72
Lentil	0.89	0.72	4.51	4.18	-3.04
Lathyrus	-0.26	0.01	0.49	1.34	-1.99
Gram	0.04	0.04	1.41	1.46	-17.41
Mungbean	0.93	0.75	4.65	4.30	0.84
Other pulses	0.15	0.11	1.93	1.74	-0.57
Tubers	0.23	0.15	2.21	1.90	7.63

Income elasticity of demand for pulses has declined from 0.64 in 1995-1996 to 0.42 per cent in 2000. This will decline further to 0.31 by 2010. With increases in income, people will prefer to consume more fish and livestock products to satisfy their protein requirements. As a result, the demand for lentil, mungbean and other pulses is likely to decline. But the income elasticity of demand for lathyrus will increase due to its increased use as feed. Thus the annual growth rate in production of pulses has to be maintained at between 1.34 per cent and 4.30 per cent, the same as or well above the population growth rate, if the increased demand is to be met from domestic production. Currently, production of all pulses, except lentil and mungbean, is experiencing a negative growth rate.

The elasticity for roots and tubers has declined to 0.23 in 2000 from 0.41 in 1995-1996. This is likely to decline further to 0.15 in 2010. This gives a required production growth rate of 1.9 per cent over the next few years, much below the annual growth rate of 7.63 per cent achieved during the last decade.

It appears that the current growth rates in the production of maize and tubers are mirroring the required growth rates in demand for those products. But special promotional and incentive schemes are necessary to boost production of pulses and millets, as the current growth rates for these products are well below the required growth rates.

10.3 Potentials for agro-processing

The rural economy of Bangladesh is characterized by an abundant supply of labour force engaged in agriculture. Agricultural commodities are grown throughout the year with seasonal surpluses in several commodities. Agro-processing gives an opportunity to prevent post-harvest losses, create value addition, promote agribusiness, generate employment, enhance farmer's income and reduce poverty. Moreover, agro-processing could have considerable impact on unpaid and surplus female labour.

As the country's economy grows and urbanization accelerates, there is an increasing trend towards the consumption of foods with characteristics that require a more advanced agro-industrial system. In the major towns and cities the emergence of a complex agri-food distribution system including supermarkets is already visible. There is a strong realization for the expansion of the agro-processing sector both at the individual and policy level. The Government of Bangladesh has been providing incentives for agro-processing and establishing agro-based labour intensive industries in the country. The government has declared this sector as the number one thrust sector out of its 16 selected sectors. National agricultural policy has also emphasized creating opportunities for establishing agro-processing and agro-based industries in the country.

There is ample opportunity for the processing and industrial use of CGPRT crop products in Bangladesh. However, people are not aware of many processing techniques and the linkages between production, processing and marketing of CGPRT crops is weak. Therefore, the opportunities for growth in production, processing and utilization have only been marginally realized.

10.4 Scope of processing

10.4.1 Maize

The use of maize lies in the manufacture of starch and other agro-industrial by-products. Puffed maize is currently gaining popularity in the country. The preparation of corn oil, glucose, alcohol, syrup, baby foods, flakes and breakfast cereals could be possible but no such facilities for processing maize have so far been developed. In recent years, poultry farms have been flourishing in the country and that has created great demand for maize to be used in animal feed. By-products of maize are used as fodder, fuel and fencing materials.

10.4.2 Millets

Millets are consumed by very poor people as a supplement to rice. Some of them mix millets with rice and parboil them together to save costly rice. In the cities and towns millets are used to prepare porridges to be consumed for breakfast. It is also usual to prepare frumenty (a type of food prepared by cooking husked millets with milk and sugar) of millets on special family occasions and festivals. The use of millets to prepare flour is yet to be popularized in the country. Millets are still husked mainly by traditional husking treadmill-type manpowered husking machines and therefore some modern machinery is needed for husking, processing and industrial uses.

10.4.3 Pulses

Pulses are used mainly for soups in Bangladesh. Fried pulses together with nuts and other ingredients are also used to prepare salty and spicy crisp snacks. In recent years, fried and processed pulses have been sold in stationary shops in small packets for consumption as a snack. Pulses, particularly mungbean and black gram, are also used to manufacture flour, which is a major ingredient for preparing coil-like juicy sweets. However, large-scale industrial uses of pulses are yet to be developed in the country.

Pulses are normally husked by paddle or hand husking indigenous appliances. These appliances can de-husk 3 to 4 kg of whole pulses in an hour. Large-scale de-husking at the traders level is performed by power operated machines. Our observation shows that these machines are utilized only at 40 to 50 per cent capacity mainly due to supply constraints.

10.4.4 Tubers

Potato and sweet potato is consumed in rural Bangladesh to supplement rice. These tubers are also used for preparing vegetables and curry. In recent years, value-added potato French fries have been prepared from fresh potato for local elite markets. Potato chips and potato flakes are also made and marketed at home and abroad. The use of sweet potato for preparing starch has been increasing in recent years.

The use of potato as French fries, chips and crackers is gaining popularity day by day. As the industrial uses of potato increase, the demand is likely to be met from increased domestic production in future.

10.4.5 Other crops

Bangladesh has a great potential for industrial uses of other CGPRT crop products. For example, cassava has a variety of industrial uses, such as the preparation of alcohol, starch, and bio-fuel for cars. Soybean is used for making soy curd, soy sauce, soy milk, soy paste, soybean cakes and soybean oil. These crops are not very popular in all areas of the country, although they are grown in some specific areas with great care and interest. The demand for these crops will increase with the expansion of their industrial uses in future.

10.5 Concluding summary

The demand for CGPRT crop products and their industrial importance were examined. It appears that the country has ample opportunities for CGPRT crop based agro-processing and value addition, which is very much consistent with present government policy. This country is endowed with fertile soil and suitable natural bounties to boost the production of CGPRT crops. There is sufficient scope to commercialize these products through enhancing processing opportunities. Increases in the purchasing power of the general population and expanding urbanization imply increasing demand for processed CGPRT crop products. This will encourage farmers to grow more of these crops for higher consumption and income. What is needed is to establish effective linkages with production, processing and marketing in the near future.

11. Potential Scope for Diversified Agriculture

11.1 Introduction

Agricultural diversification is a necessary condition for food and nutritional self-sufficiency in Bangladesh. In recent years, farmers have been giving importance to the cultivation of secondary crops and they are slowly moving towards diversification. The Government of Bangladesh continues to promote the production of pulses, oilseeds and spices, and is financing a project on crop diversification. Thus, national consensus has been built up for the production of more secondary crops and the diversification of agriculture in Bangladesh. However, the progress so far made towards this goal is limited. The country needs to accomplish more tasks in the days ahead for speedy achievement of the goal of diversification. This will require proper realization of driving and constraining forces for diversification of agriculture through the expansion of secondary crop cultivation in Bangladesh.

11.2 Driving forces for diversification

In Bangladesh, there is ample scope for diversification of agriculture with CGPRT crops. Recent self-sufficiency in rice production is likely to act as a driving force to such diversification. The people of Bangladesh are now more conscious about nutritional aspects of their diets and they are diversifying their food habits. Government policies have favoured diversification in recent years. This will encourage the production of more pulses and other CGPRT crops in future.

CGPRT crops do compete with rice and wheat under favourable environments. But most CGPRT crops (for example, pulses and millets) are grown in less favourable situations. These crops require less inputs and intercultural operations than rice. With the expansion of irrigation and increases in cropping intensity, the cultivation and production of these crops are likely to increase in future.

Most CGPRT crops are grown in seasons when farmers do not have major cereals to produce. Thus the production of these crops creates additional employment opportunities for the farmers and their family members. Besides, some of these crops, especially pulses enrich the soil by fixing nitrogen to the soil and reducing the possibility of environmental degradation by using less irrigation water and chemicals. Thus the area under these crops may increase in future for the sake of organic agriculture.

The animal and poultry sector in Bangladesh has been expanding quite rapidly in recent years. This has created more demand for maize and pulses as fodder. Farmers are willing to produce more coarse grains and pulses to have more meat, milk and eggs in the country.

Processing and industrial uses of CGPRT crops have been expanding in Bangladesh, particularly in the towns and cities. This has created more demand for CGPRT crops, which is likely to encourage production and the devotion of more acreage under CGPRT crops.

Cold storage, marketing and credit facilities have encouraged the production of potato and its growth rate has increased significantly in recent years. Ensured marketing of maize to be used by poultry industries has also been encouraging the production of maize in the country. These facilities will increase further in future, which will encourage production of CGPRT crops and diversification of agriculture.

Production of CGPRT crops has more comparative advantage than that of the main staple food rice. Economic and financial returns are also satisfactory for CGPRT crops. This will promote diversification in crop agriculture.

Income elasticity of demand for CGPRT crop products is higher than that of rice. As consumer's income rises, the demand for CGPRT products will increase faster than the demand for rice. This will encourage diversification.

11.3 Constraining forces for diversification

There are several constraints to increase the production of CGPRT crops in Bangladesh. It is apparent that better land is allocated to more important staple crops such as rice and wheat, while coarse grains, tubers and pulses are often grown on marginal and less fertile land. Farmers are used to cultivating these crops under rainfed conditions in harsh environments with minimum tillage, inputs and care. Therefore, per unit production of these crops is low.

Disease and insect pests are the major biotic constraints to grain legume production in Bangladesh. Lack of seed dormancy and weeds also limit the productivity of some legumes. Besides, a range of abiotic constraints (climatic and soil factors) limit the productivity of both winter and summer food legumes. Among these drought, excess moisture, and adverse temperature and soil conditions are important. Research and development programmes to overcome these constraints are insufficient in the country for these crops contributing to low yield.

The production of millets and pulses are characterized by very low yield. The low yields are the result of combined factors namely a lack of improved seeds, lack of improved management practices, and low use of inputs. In addition to this, production is characterized by a lack of price incentives. Research and breeding programmes on millets, pulses and sweet potato are far behind what has been done for the major crops.

Pulses, maize, millets and sweet potato are often intercropped. It means that farmers cannot rely merely on individual CGPRT crops for their income. They therefore depend on intercropping as a traditional way of minimizing risk. It is also an indication that improved technologies are less available to the farmers for the intensive production of CGPRT crops.

At a research institute level, there are some improved varieties and new technology packages available for CGPRT crops. But these technologies are adopted on only a limited scale due to the lack of training for and motivation of the farmers. There is also a lack of credit and financial support for the extended production of CGPRT crops in Bangladesh.

The market for maize, potato and pulses has extended but for millets and sweet potato is still limited. In fact, sweet potato and millets are produced in remote areas of the country and these products are mostly used for local consumption. Transportation of these products to other areas of the country is often difficult and costly, which limits production.

The lack of appropriate storage facilities is another constraint to the production of CGPRT crops. There are sufficient cold storage facilities for potato but no such facilities have yet been developed for sweet potato. Other crops like pulses, maize and millets are traditionally stored in earthen pots, gunny bags, bamboo baskets and tin containers. Iron made oil drums are also used in some cases for storing these crop products. In most storing methods grains and pulses easily absorb moisture from the air, which leads to various types of deterioration and infestation. Moreover, incidence of pests and disease, and damage by rodents were also reported by farmers in the study areas.

Most CGPRT crops are not considered by institutional sources for credit provision. These are produced in small quantities by poor farmers, who are unable to market them profitably. The inability of farmers to organize themselves to promote their collective interests for financing the production and marketing of produce is an important constraint to CGPRT crop production in Bangladesh.

Another constraint to the consumption of millets, sweet potato and pulses is that varieties of food items to be derived from them is often very limited. Commercial use of these products for animal feed and as raw materials in industry have not really started in Bangladesh. This is

one of the main reasons for the slow growth of CGPRT crops, their products and by-products in the country.

11.4 Concluding summary

The scope of agricultural diversification has expanded in recent years with the achievement of self-sufficiency in rice production. Increased cold storage, credit, processing and marketing facilities are likely to stimulate more industrial uses of agricultural products, which will encourage diversification. CGPRT crops have comparative advantage in production as human food and also as animal feed and their extended cultivation will help increase the magnitude of diversification. There are, however, several constraints to increasing the production of CGPRT crops in Bangladesh. The most important one is the low yield rates for some CGPRT crops. Others include a lack of price incentives, lack of credit, poor knowledge of their nutritional value and limited industrial use. Research and development activities on the technological front and appropriate policy support from the government are likely to help realize the potential benefits of CGPRT crops and increase their production and consumption in future.

12. Towards the Development of Sustainable Diversified Agriculture for Poverty Alleviation in Bangladesh: A Search for Effective Policy

Agriculture in Bangladesh is dominated by the crop sector. Rice dominates crop agriculture with more than 75 per cent of the cropped area under rice cultivation. Any new seed-fertilizer- irrigation technology has favoured rice and wheat production for achieving self-sufficiency in food grains. As a result, secondary crops namely, coarse grains, pulses, roots and tubers (CGPRT) have remained largely untouched by the growth process. Some of these crops have even exhibited declining trends in recent years. The country has become more dependent on imports of maize and pulses to meet the growing demand for food, animal feed, fuel and industrial uses. Diversification of the crop sector through the promotion of CGPRT crop cultivation is likely to help import substitution, provide opportunities for value addition after processing, improve soil quality, mitigate risk, ensure food security and create employment for both men and women.

This study was conducted in selected areas of Bangladesh to examine the possibilities of promoting diverse agriculture with CGPRT crops. The study covered some important coarse grains, pulses and tubers widely grown in Bangladesh. The specific crops investigated for this study are maize, millets, lentil, mungbean, potato and sweet potato.

Coarse grains occupy 0.79 per cent of the total area under cultivation and contribute 0.88 per cent to total food-grain production. Major coarse grains in Bangladesh are maize and millets. The area and production of maize have been increasing rapidly, while the area and production of millets have stagnated over time. This study provided information on maize and millets (Cheena and Kaon) through field investigation.

Pulses occupy 3.3 per cent of gross cropped area. Important pulses include lathyrus, lentil, mungbean, black gram, chickpea, fieldpea, cowpea and pigeonpea. In terms of area under cultivation, lathyrus, lentil and mungbean occupy the first, second and third position, respectively, of pulses' production in Bangladesh. Lathyrus is used mainly as a fodder crop while lentil and mungbean are used mainly for human consumption. Total area and production of pulses have shown a long-term increasing trend, but have declined in recent years. There was a little increase in yield rates of pulses due to the adoption of new techniques, but that was more than offset by the decline in area under cultivation. This study provided information on lentil and mungbean on the basis of field investigations conducted in different areas of Bangladesh.

Tubers account for 2.1 per cent of total cropped area. The principal tuber and root crops are potato and sweet potato. The area, production and yield of potato have increased, but that of sweet potato has declined over time. Currently, potato accounts for 87 per cent of total production of tubers in the country. The production of potato has significantly increased in recent years due to the adoption of new techniques in its cultivation and the development of cold storage facilities for its preservation. This study generated data on the production of potato and sweet potato on the basis of field investigations conducted in Bangladesh in 2003.

Bangladesh is a poor country with annual per capita income below US$ 400. The density of the population per square kilometer is 834, one of the highest in the world. Agriculture is the main occupation of the population contributing around 23 per cent to the nation's GDP. The share of the crop sector to agricultural value added is 67 per cent and rice alone contributes 79 per cent to the value of crop output. Poverty is endemic in the country with about 50 per cent of the population living below the poverty line. The distribution of income has been widening over

time and there is a growing concern for the diversification of agriculture to reduce hunger, malnutrition and poverty. Fortunately, secondary crops (CGPRT crops) offer one of the best possible options for increasing agricultural diversity in the country.

In Bangladesh, diversification of agriculture has been promoted slowly over the last three decades. Meanwhile, diversification of food consumption has also been promoted. There is a need to expand appropriate processing techniques and value addition facilities to further promote the pace of diversification of consumption in future. It is also necessary to introduce new production technologies, expand their adoption and create suitable institutions and infrastructure to accelerate the pace of diversification of products in the country. A mechanism to integrate the production, processing and marketing of CGPRT crop products has to be developed to safeguard the interests of both producers and consumers.

Financial and economic returns from producing CGPRT crops were examined from data generated through a survey of 400 farm households in the study areas. Results show that CGPRT crops generate satisfactory returns over variable and full costs. The returns were high for potato, maize and pulses mainly due to the adoption of new techniques of production. The returns were low for millets due to non-adoption of improved cultivation practices. Sweet potato was highly profitable even under traditional systems of production mainly due to higher yield.

The impact of public policy on the financial incentives for the production of CGPRT crops was examined by calculating Nominal Protection Co-efficient (NPC), Nominal Rate of Protection (NRP), Effective Protection Co-efficient (EPC) and Effective Rate of Protection (ERP). Results show that the domestic market for CGPRT crops is not protected and the level of public support declined during the 1990s and beyond due to the withdrawal of input subsidies, output support and import liberalization. Recent increases in production of some CGPRT crops were mainly due to yield improvements through the adoption of new varieties. However, domestic production of maize and pulses would require substantial protection in future for import substitution.

A measure of comparative advantage was used to examine the efficiency of using resources to produce CGPRT crop products at home instead of importing the same from abroad. Results show that Bangladesh has comparative advantage in producing all CGPRT crops, as DRC values have been less than one for the last three decades. The value was positive for potato even at export parity level during the most recent years. In contrast, DRC values were found to be much higher for coarse rice indicating comparative disadvantage for its higher production. Thus it reveals that the country has enough potential for the diversification of crop agriculture through the expansion of secondary crops (CGPRT crops).

Incentives to produce a crop depend, among other things, on marketing efficiency. This was examined for CGPRT crop products by calculating marketing costs and margins, and seasonal and spatial price fluctuations during the study period. It revealed that there is substantial inefficiency in the marketing of some CGPRT crops. The inefficiency was high for perishable CGPRT products (potato and sweet potato) and low for pulses and coarse grains. There is scope to improve marketing efficiency through the expansion of cold storage facilities, creation of processing establishments, tackling undue interruption of illegal agents, ensuring better communication and regular price information, and the formation of marketing cooperatives.

Recent economic reforms and trade liberalization in agriculture called for reductions of tariff and non-tariff barriers, trade distorting domestic support, and export subsidies. Bangladesh as a least developed country is exempt from reduction commitments. However, the country has liberalized its economy substantially in recent years through the reduction of tariff rates and the withdrawal of agricultural subsidies. The un-weighted average tariff rate for all agricultural products declined to 15 per cent in 2002-2003 from 55 per cent in 1991-1992. Subsidies on irrigation and fertilizer declined from 2.53 per cent of the value of unassisted output in 1988-1989 to 0.45 per cent in 2002-2003. Moreover, there is a very low rate of subsidies on agricultural exports. However, the impact of trade liberalization policies was not favourable on

the agricultural economy of Bangladesh. Total agricultural exports increased by about 2 per cent but agricultural imports increased by 9 per cent per year during the 1990s. Imports of maize and pulses increased significantly over that period. Commercial imports of food grains also increased but the magnitude of food aid dropped over the same period. This would imply that Bangladesh has had to face more losses than it has enjoyed gains from the eventualities of recent trade liberalization. Very recently, the country produced a small surplus of food grains, but there is still a huge deficit in the production of other crops. The deficit is much larger for CGPRT crops, particularly for maize and pulses, which has increased over time with the increase in population. It is possible to have a significant increase in these crops to meet the current demand. For that reason, more investment on yield increasing technology generation and adoption is necessary, which will accelerate the speed of diversity in agriculture.

Bangladesh is a poor country with annual per capita income less than US$ 400. About 50 per cent of the population live below the poverty line and most of them suffer from chronic malnutrition. The expansion of CGPRT crops will promote the diversification of the rural economy, stimulate growth in the non-farm sector, raise the income and wages of the people and enable the supply of low-cost food to improve nutritional status and food security of the poor. Thus expanded production of these crops is likely to reduce the incidence of poverty in the country. To achieve this goal, target-oriented programmes to enhance the quality of life of poor people through diversification of agriculture is necessary. Besides, training for the creation of nutritional awareness and effective demand for nutrition-rich CGPRT products at the farm family level is also necessary. Moreover, the delivery of micro-credit, development of infrastructures and establishment of marketing linkages are required to promote CGPRT crop product based industries in the country.

Bangladesh has achieved self-sufficiency in rice production in recent years. This has expanded the scope of agricultural diversification in the country and farmers can now produce more secondary crops to diversify their food basket. Increased research and extension services, cold storage, credit, processing and marketing facilities are likely to stimulate more industrial uses of agricultural products, which will encourage diversification. CGPRT crops have comparative advantage in production as human food and also as animal feed and their extended cultivation will help increase the magnitude of diversification. There are, however, several constraints to increasing production of CGPRT crops in Bangladesh. The most important one is the low yield rate for some CGPRT crops. Others include a lack of price incentives, lack of credit, poor knowledge of their nutritional value and limited industrial use. Research and development activities on a technological front and appropriate policy support from the government are likely to help realize the potential benefits of CGPRT crops and increase their production and consumption in future. Specific recommendations are given in the following Chapter with a view to promote the production and utilization of secondary (CGPRT) crops in Bangladesh.

13. Conclusions and Recommendations

This study generated both primary and secondary data from Bangladesh on some important CGPRT crops. Analysis of the data shows that maize, millets, pulses, potato and sweet potato (CGPRT or secondary crops) have enough potential for crop diversification, employment creation, income generation, reducing malnutrition and poverty alleviation in rural Bangladesh. These crops are profitable and have comparative advantage in production. The demand for these crops is likely to increase with urbanization and increases in per capita income and the scope of industrial uses of these crops is high in the country. Farmers of the country should be encouraged to produce more of these crops through area expansion and adoption of improved technologies in the process of production and consumption. Specific recommendations for the promotion of production and utilization of CGPRT crops are given below in order to guide policy and research in the country in future.

1. Improved production technologies for secondary (CGPRT) crops have been very limited in Bangladesh. Whatever new technologies are available from research stations have not yet been widely circulated amongst the farmers. Farmers try to produce these crops with minimum tillage and cash cost. This is common particularly for millets, pulses and sweet potato. Breeding and agronomic research for the generation of improved technology in the production of CGPRT crops that fit well into the cropping system should receive high priority. This will call for high budgetary provisions for research on CGPRT crops.

2. The spread of new technology on CGPRT crops is very limited. Efforts should be made to disseminate research findings to the farmers regularly through the normal extension system, training and field demonstrations. It is also necessary to arrange training programmes for extension agents for effective dissemination of technology packages to the farmers.

3. The problem of insect pests and disease hinder production of CGPRT crops in Bangladesh. Their control in the field as well as during storage will encourage more cultivation of CGPRT crops. Research and extension work in this field is necessary.

4. Irrigation is sometimes helpful for the production of coarse grains, pulses and tubers. Large-scale irrigation may divert farmers from cultivation of secondary crops to rice cultivation. In that case some small-scale irrigation devices of minimal cost may be useful for timely cultivation and greater production of CGPRT crops. Thus an appropriate irrigation policy has to be designed carefully for CGPRT crops.

5. Some CGPRT crops, particularly pulses, promote crop rotation and fix nitrogen in the soil. This benefit cannot be fully realized unless cropping system research is encouraged and a cropping system is developed with CGPRT crops where net return per unit of land would be higher. Therefore, attention should be given to cropping system research with an emphasis on CGPRT crops.

6. Post-harvest losses are an important problem for CGPRT crops. Therefore, storage facilities should be improved to save products from post harvest losses. Cold storage facilities should be extended to sweet potato.

7. Production and processing of CGPRT crops is hampered due to financial constraints. Farmers producing CGPRT crops should be provided with production loans and small processors should be brought under the network of micro credit. A special credit programme should be launched for the production and processing of CGPRT crops and their products.

8. Farmers growing CGPRT crops sell most of their produce immediately after harvest, so they are unable to receive the benefits of price hikes a few months after harvest. The storage-cum-credit scheme now under operation through the Department of Agricultural Marketing should be extended to CGPRT crop growers so that they can store their commodities and borrow from banks to meet their urgent cash needs.

9. Marketing costs of CGPRT crops are high. This can be reduced through the development of a contract growing system between farmers and processors/millers. More processing plants and mills should be established in the intensive CGPRT crop growing zones to shorten the marketing channel, and reduce marketing costs and profits. Cooperative marketing systems should be introduced.

10. There is evidence of spatial price difference for CGPRT crops. A lack of market information, underdeveloped infrastructure and a lack of appropriate transport facilities are the main reasons for such differences. Better transportation, communication and information systems would help minimize such differences.

11. Processing of CGPRT crop products is an important component in the marketing and utilization system. Traditional processing devices create employment opportunities for rural people, particularly for women. These devices need to be improved. Also attention should be given to modernization and capacity utilization of processing mills and plants. Commercial uses of CGPRT crop products for animal feed and as raw materials to industry have to be researched and encouraged.

12. Currently there are price policies only for rice and wheat. A rational price policy should also be formulated to ensure remunerative prices to CGPRT crop growers. This can be made effective through the procurement of produce by the government from the growers and distribution to the consumers in open-market sales. To this end, the procurement price should be determined ahead of harvest for each CGPRT crop. An agricultural price commission should be formed to recommend procurement prices, regularly monitor spatial and temporal price fluctuations of agricultural commodities including CGPRT crop products, and recommend interventions.

13. The linkages between production, processing and marketing are very weak in Bangladesh. Institutional arrangements should be made to integrate them appropriately in rural areas.

14. Farmers do not use the required material inputs for CGPRT crops due to their financial inability. Special subsidies should be provided for inputs to be used for CGPRT crops to encourage production. Moreover, farmers should be protected from international competition through the imposition of high tariffs on imports of CGPRT crop products, particularly on imports of maize and pulses.

15. Socio-economic research on CGPRT crops is insufficient in Bangladesh. For appropriate policy decisions, profitability analysis, marketing research and demand projections are necessary at regular intervals. This has to be ensured.

16. The Government of Bangladesh has committed to a policy of larger participation of the private sector and shrinkage of the role of the public sector. This situation would necessitate continuous studies on the structure, conduct and performance of the marketing system in relation to CGPRT crops. The NARS institutes in Bangladesh should take the lead in this respect and undertake studies to guide future policy directions.

17. Most people in Bangladesh do not know the high calorie and protein content of CGPRT crops. They need to be made aware of it. Moreover, different processed food items from CGPRT crops have to be demonstrated to make them popular among all classes of society. Both public and private initiatives are necessary in this regard.

18. The mass media (radio, television, newspapers etc.) should come forward to focus on the utility of CGPRT crop products as nutritionally rich food and inform people about the versatile use of CGPRT crops, especially pulses, potato, sweet potato and maize.

19. Some CGPRT crops are now cultivated on marginal land in particular regions but seeds from these crops are not available all over the country. Efforts should be made for the collection and preservation of germplasm of these crops to save them from the threat of possible extinction. At the same time, improved seeds developed by research stations should be multiplied and distributed to farmers by the BADC.

20. Different countries in this region have achieved technological advancements in the production and processing of secondary/CGPRT crops at different levels. These success stories need to be properly documented and widely disseminated among people of this region. Moreover, regional cooperation is required to carry forward research and development activities for the promotion of diversification and sustained agricultural growth in future.

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Appendix A. Tables

Table A.1 Selected social indicators of Bangladesh

Indicator	1981	1991	2001
Fertility rate (children per woman)	5	4.3	2.9
Infant mortality rate (per 1,000 live births)	101.4	94	66.3
Crude birth rate (per 1,000 population)	33.4	32.8	19.9
Crude death rate (per 1,000)	10.2	11.3	4.8
Life expectancy (years)	56.9	56.0	60.6
Gross primary enrollment, both sexes (%)*	61	72	91
Gross secondary enrollment, both sexes (%)	18	19	51
Female gross primary enrollment (%)	46	66	93
Female gross secondary enrollment (%)	9	13	56
Adult literacy rate (%)	29.0	35.0	45.0

Source: Household Income and Expenditure Survey 2000, Population Census results, and World Bank (2003b).

Table A.2 Employment of labour force by sector

Sector	Year	
	1995-1996	1999-2000
Agriculture	63.2	62.3
Mining	-	0.7
Manufacturing	7.5	7.4
Construction	1.8	2.1
Power and water	0.2	0.2
Trade and hotel	11.2	12.0
Transport	4.2	4.6
Banking	0.4	0.7
Private services	9.3	10.0
Others	2.2	--

Source: Labour Force Survey (1995-1996; 1999-2000).

Table A.3 Index of wages by sector (1969-1970 = 100)

Year	Index of real wages				
	General	Industry	Construction	Agriculture	Fisheries
1990-1991	107	114	107	95	105
1991-1992	107	113	104	98	107
1992-1993	113	119	109	105	113
1993-1994	114	121	106	106	113
1994-1995	111	121	100	103	110
1995-1996	114	123	105	104	112
1996-1997	120	130	111	109	119
1997-1998	122	137	114	107	117
1998-1999	118	131	113	102	111
1999-2000	121	137	116	103	113
2000-2001	125	142	118	107	115
2001-2002	130	150	121	112	119

Source: Bangladesh Bureau of Statistics.

Table A.4 Macro-economic indicators of Bangladesh

Indicators	1991-1992	1995-1996	1999-2000	2001-2002
GDP at current market price (taka in billions)	1,195.4	1,663.2	2,370.9	2,732.0
GDP growth rate at constant (1995-1996) prices	5.0	4.6	5.9	4.4
Population (millions)	113.0	120.8	128.1	131.6
Per capita GDP at current prices (taka)	10,579.0	13,768.5	18,507.9	20,760.0
Average exchange rate with US dollar	38.1453	40.8365	50.3112	57.4347
As percentage of GDP				
Consumption	86.1	85.3	82.1	81.8
National savings	19.3	20.0	23.1	23.4
Total investment	17.3	20.0	23.0	23.1
Overall budget deficit	-4.7	-4.7	-6.1	-4.7
Imports	11.3	16.9	17.8	18.0
Exports	6.3	9.5	12.2	12.6
Rate of inflation (%)	4.6	6.7	3.4	2.4
Foreign exchange reserve (million US$)	1,608	2,039	1,602	1583
Foreign exchange reserve (months of imports)	5.5	3.5	2.3	2.2

Source: GOB (2003).

Table A-5 Current dietary pattern in Bangladesh compared with expected patterns

Food items	Adequate intake [1] (grams)	Target intake[2] (grams)	Current intake[3] (grams)	Minimum required intake[4] (grams)	Energy		Food gap[5] %
					Kcal	%	
Cereals	490	372	475.8	450	1,555.2	70.2	-5.7
Tubers	100	130	70.9	70	61.7	2.8	-1.3
Vegetables	125	132	140.5	150	65.8	3.0	6.3
Pulses	30	66	15.8	30	105.0	4.8	47.3
Edible oils	20	38	12.8	20	180.0	8.2	36.0
Fruits	50	57	28.4	50	50.0	2.3	43.2
Sweeteners	10	28	6.85	10	40.0	1.8	31.5
Fish	45	50	38.5	60	60.0	2.7	35.8
Meat	20	22	13.3	30	33.0	1.5	55.7
Eggs	14	7	5.3	10	16.7	0.7	47.0
Milk	30	47	29.7	50	32.6	1.5	40.6
Total	934	949	837.8	930	2200	100	9.9

[1]Bangladesh National Nutrition Council, Dhaka.
[2]Ministry of Food, Dhaka.
[3]Household Expenditure Survey 2000.
[4] Author's estimate.
[5] (Minimum required intake- current intake)/(Minimum required intake)*100.

Table A.6 Values of Simpson Index of diversity over time

Year	SID	Average of decade
1971-1972	0.753535	
1972-1973	0.782523	
1973-1974	0.756836	
1974-1975	0.752394	
1975-1976	0.739617	
1976-1977	0.740509	
1977-1978	0.753944	
1978-1979	0.759360	
1979-1980	0.757601	0.755147
1980-1981	0.758371	
1981-1982	0.754825	
1982-1983	0.758936	
1983-1984	0.784475	
1984-1985	0.795371	
1985-1986	0.791190	
1986-1987	0.794423	
1987-1988	0.800292	
1988-1989	0.790030	
1989-1990	0.788354	0.781627
1990-1991	0.788784	
1991-1992	0.784120	
1992-1993	0.780957	
1993-1994	0.787816	
1994-1995	0.785125	
1995-1996	0.778808	
1996-1997	0.780059	
1997-1998	0.793852	
1998-1999	0.800989	
1999-2000	0.791123	
2000-2001	0.769552	
2001-2002	0.768551	0.784145

Table A.7 Trend growth rates for real prices of CGPRT crops in the international market compared with Bangladesh during 1991-2001

Crop	Market location	Annual growth rate (%)
Maize	USA	-4.83
	India	-3.23
	Bangladesh	-4.42
Millets	USA	-3.37
	India	-4.44
	Bangladesh	-1.37
Lentil	USA	-0.34
	Turkey	0.33
	Nepal	0.20
	Bangladesh	-0.48
Potato	USA	-2.67
	Netherlands	2.16
	Bangladesh	-5.09
Sweet potato	USA	-0.78
	Australia	-1.64
	Bangladesh	1.90

Source: FAO
Note: Growth rates have been calculated by fitting semi-logarithmic trend lines.

Table A.8 Comparative yield performance of CGPRT crops in Bangladesh

Crop	AGRIDIV Study Yield (kg/ha)	National average[1] Yield (kg/ha)	Different study			
			Yield (kg/ha)	Area	Authors	Title
Lentil	932	750	789	Pabna Faridpur	Rashid, *et al.*, 2001	Crop Cultivation Practices: Input Output Relationship of Major Crops in Bangladesh
Maize	5,738	5,740	5,700	Rangpur, Savar		
Mungbean	1,189	670	1,151	Jessore, Jhenaidah, Chuadanga	Karim *et al.*, 2002	Profitability and Technical Efficiency of BARI Improved Mungbean Cultivation in Some Selected Areas of Bangladesh
Potato	26,966	13,800	36,955	Munshiganj	Huq *et al.*, 1995	Potato Production in CDP Demonstration Area-Yield Gap Analysis
Sweet potato	12,868	9,200	11,044 -13,101	Jamalpur, Bajitpur, Bhola	Elias *et al.*, 1984	Sweet Potato Production in Bangladesh-Agro Economic Survey and Constraints to it's Higher Production at Farm Level
Cheena	1,721	794	1,509 -2,031	Pabna, Tangail	Elias *et al.*, 1984	Millet Production in Bangladesh-An Agro-Economic Profile of Cheena
			2500-3000			BARI Technology Hand Book
Kaon	1,525	794	2000-2500			BARI Technology Hand Book

[1] MOA and BARI.

Table A.9 Use of inputs in production of CGPRT crops in Bangladesh

Inputs	Maize	Cheena	Kaon	Lentil	Mungbean	Potato	Sweet potato
Human labour (man-day/ha):							
Family	55	30	30	54	47	79	87
Hired	102	24	41	34	79	169	72
Total	156	54	71	88	126	208	159
Animal power (pair-day/ha):							
Family	2.01	6	3	8	3	0.84	16
Hired	0	4	8	11	8	0.10	15
Total	2.01*	10	11	18	11	0.94**	31
Seed (kg/ha):							
Owned	0	17	4	37	9	1,145	56,000
Purchased	19	1	8	7	13	1,141	6,000
Total	20	18	12	45	21	2,286	62,000***
Cow dung (kg/ha):							
Owned	1,176	804	525	931	2,924	4,434	1,319
Purchased	515	0	1,475	150	798	2,802	0
Total	1,691	804	2,000	1,081	3,722	7,236	1,319
Fertilizer (kg/ha):							
Urea	458	77	60	24	31	465	64
TSP	231	6	0	45	40	410	97
MP	160	1	0	21	18	357	21
Gypsum	76	0	0	0	6	60	0
Zinc	5	0	0	0	0	4	0
Boron	1	0	0	0	0	2	0
Total	931	84	60	90	95	1,298	182

* Plus two cross plowing by power tiller.
** Plus three to four cross plowing by power tiller.
*** Cutting of vine.
Source: Field survey.
Note: Farmers of the study areas reported to have used cow dung for producing cheena and kaon, and chemical fertilizers for sweet potato. Generally farmers of other areas of the country do not use much manure and fertilizers for these crops. Some farmers of the study areas have the impression that the use of organic and inorganic fertilizers for producing minor crops will increase fertility of soil and help production of the next major crop.

Table A.10 Un-weighted tariff rates and value-added tax on major agricultural products in Bangladesh

(%)

	Group	1991-1992				1992-1993			
		CD+LF+IDS	VAT	SD	Total	CD+LF+IDS	VAT	SD	Total
1	Rice	16.44	14.81	0.00	31.25	8.98	12.38	0.00	21.36
2	Wheat	16.44	0.00	0.00	16.44	8.98	0.00	0.00	8.98
3	Maize								
4	Sugar	81.44	12.25	0.00	93.69	81.48	12.25	0.00	93.73
5	Oilseed	41.44	0.00	0.00	41.44	27.73	0.00	0.00	27.73
6	Edible oil: crude	58.94	8.88	0.00	67.82	50.23	6.72	0.00	56.95
7	Edible oil: refined	93.44	14.05	0.00	107.49	83.48	12.55	0.00	96.03
8	Onion	31.44	0.00	0.00	31.44	31.48	0.00	0.00	31.48
9	Chilies (dry)	1.44	5.08	0.00	6.52	12.73	8.63	0.00	21.36
10	Potato	101.44	0.00	0.00	101.44	76.48	0.00	0.00	76.48
11	Milk	44.77	8.08	0.00	52.86	45.41	4.86	0.00	50.27
12	Pulses	21.44	0.00	0.00	21.44	16.48	0.00	0.00	16.48
		1995-1996				**1996-1997**			
1	Rice	1.22	0.04	0.00	1.26	1.28	0.00	0.00	1.28
2	Wheat	8.72	0.67	0.00	9.39	8.78	0.68	0.00	9.46
3	Maize								
4	Sugar	31.22	4.71	0.00	35.93	31.28	4.74	0.00	36.02
5	Oilseed	18.10	1.37	0.00	19.47	16.13	1.39	0.00	17.52
6	Edible oil: crude	31.22	5.46	0.00	36.68	31.28	4.06	0.00	35.34
7	Edible oil: refined	38.72	5.84	0.00	44.56	38.78	4.99	0.00	43.77
8	Onion	31.22	2.36	0.00	33.58	31.28	2.37	0.00	33.65
9	Chilies (dry)	23.72	0.00	0.00	23.72	23.78	0.00	0.00	23.78
10	Potato	46.22	3.48	0.00	49.70	46.28	3.50	0.00	49.78
11	Milk	46.22	5.73	0.00	51.95	46.28	10.10	0.00	56.38
12	Pulses	12.47	0.95	0.00	13.42	12.53	0.96	0.00	13.49
		1998-1999				**1999-2000**			
1	Rice	1.08	0.00	0.00	1.08	1.00	0.00	0.00	1.00
2	Wheat	7.08	0.57	0.00	7.65	5.50	0.50	0.00	6.00
3	Maize								
4	Sugar	33.58	4.74	0.00	38.32	28.50	3.99	0.00	32.49
5	Oilseed	14.71	1.18	0.00	15.88	12.58	1.01	0.00	13.59
6	Edible oil: crude	21.08	2.46	0.00	23.54	18.50	2.49	0.00	20.99
7	Edible oil: refined	36.91	4.46	0.00	41.37	33.86	4.16	0.00	38.02
8	Onion	33.58	2.37	0.00	35.95	28.50	2.00	0.00	30.50
9	Chilies (dry)	22.33	0.00	0.00	22.33	22.25	0.00	0.00	22.25
10	Potato	43.58	3.12	0.00	46.70	41.00	2.93	0.00	43.93
11	Milk	43.58	9.48	0.00	53.06	41.00	9.50	2.70	53.21
12	Pulses	6.08	0.54	0.00	6.62	4.75	0.41	0.00	5.16
		2002-2003				**2003-2004**			
1	Rice	7.5	0	0	7.5	7.5	0	0	7.5
2	Wheat	13.5	0	0	13.5	7.5	0	0	7.5
3	Maize	6.5	0	0	6.5	7.5	0	0	7.5
4	Sugar	50.5	0	23.5	74.0	48.0	4.0	30.0	82.0
5	Oilseed	6.5	0	0	6.5	7.0	0	0	7.0
6	Edible oil: crude	22.5	0	0	22.5	22.5	0	0	22.5
7	Edible oil: refined	22.5	0	0	22.5	22.5	0	0	22.5
8	Onion	29.0	0	0	29.0	29.5	0	0	29.5
9	Chilies (dry)	22.5	0	0	22.5	22.5	0	0	22.5
10	Potato	39.0	0	0	39.0	37.0	0	0	37.0
11	Milk	39	15.0	15.0	74.0	37.0	15.0	25.0	77.0
12	Pulses	7.5	0	0	7.5	7.5	0	0	7.5

Source: National Board of Revenue and Dowlah (2003).

Note: CD = Customs duties; LF = License fees; IDS = Infrastructure development surcharge; SD = Supplementary duty; VAT = Value-added tax.

Table A.11 Export of agricultural commodities from Bangladesh (Million US$)

Year	Raw jute	Tea	Frozen food	Agri products	Jute products	Hides and skins	Crops (Total)	Agriculture (Total)	Total exports
1991-1992	85	32	131	10	301	144	428	703	1,994
1992-1993	74	41	165	15	292	148	422	735	2,383
1993-1994	57	38	211	15	284	168	394	773	2,534
1994-1995	79	33	306	13	319	202	444	952	3,473
1995-1996	91	33	314	22	329	212	475	1,001	3,884
1996-1997	116	38	321	29	318	195	501	1,017	4,427
1997-1998	108	47	294	39	281	190	475	959	5,172
1998-1999	72	39	274	22	304	168	437	879	5,324
1999-2000	72	18	344	18	266	195	374	913	5,752
2000-2001	67	22	363	18	230	254	337	954	6,467
2001-2002	61	17	276	23	244	207	345	828	5,986
Annual growth rate (%)	-1.25	-6.55	7.33	6.42	-2.23	3.59	-1.97	1.96	11.9

Source: Export Promotion Bureau.
Note: Growth rates have been calculated by fitting semi-logarithmic trend lines.

Table A.12 Import of agricultural commodities to Bangladesh (Million US$)

Year	Rice	Wheat	Oilseeds	Raw cotton	Edible oil	Maize	Pulses	Agriculture (Total)	Total imports
1991-1992	4	251	30	95	185	0.000	14.666	579.67	3,516
1992-1993	0	176	35	91	113	0.002	14.154	429.16	4,071
1993-1994	23	145	65	71	140	0.013	28.450	472.46	4,191
1994-1995	220	256	80	135	220	0.448	9.279	920.73	5,834
1995-1996	358	228	89	185	179	1.959	23.604	1,064.56	6,947
1996-1997	28	156	62	195	216	2.436	52.365	711.80	7,152
1997-1998	247	122	93	207	216	1.452	43.608	930.06	7,520
1998-1999	680	317	100	233	287	5.077	70.870	1,692.95	8,006
1999-2000	115	266	90	277	256	18.923	112.999	1,135.92	8,374
2000-2001	172	177	64	360	218	26.575	85.749	1,103.32	9,335
2001-2002	15	171	72	312	251	32.574	92.890	946.46	8,540
Annual growth rate (%)	30.83	-0.25	7.51	15.21	6.08	75.45	22.96	9.04	9.59

Source: GOB (2003).
Note: Growth rates have been calculated by fitting semi-logarithmic trend lines.

Table A.13 Foreign assistance to Bangladesh (million US$)

Year	Donation	Loan	Total
1971-1972	245	26	271
1972-1973	486	65	551
1973-1974	218	243	461
1974-1975	375	526	901
1975-1976	234	567	801
1976-1977	256	279	535
1977-1978	393	441	834
1978-1979	502	528	1,030
1979-1980	650	573	1,223
Growth rate (1971-1980) (%)	7.99	32.02	14.28
1980-1981	593	553	1,146
1981-1982	654	588	1,240
1982-1983	587	590	1,177
1983-1984	733	535	1,268
1984-1985	703	566	1,269
1985-1986	546	760	1,306
1986-1987	661	934	1,595
1987-1988	823	817	1,640
1988-1989	673	995	1,668
1989-1990	766	1,044	1,810
Growth rate (1980-1990) (%)	2.2	7.89	5.19
1990-1991	831	901	1,732
1991-1992	817	794	1,611
1992-1993	818	857	1,675
1993-1994	710	849	1,559
1994-1995	890	849	1,739
1995-1996	677	766	1,443
1996-1997	736	745	1,481
1997-1998	503	748	1,251
1998-1999	669	867	1,536
1999-2000	726	862	1,588
2000-2001	504	865	1,369
2001-2002	479	963	1,442
Growth rate (1990-2002) (%)	-4.6	0.43	-1.71
Growth rate (1971-2002) (%)	2.71	5.9	3.76

Source: GOB (2003).
Note: Growth rates have been calculated by fitting semi-logarithmic trend lines.

Table A.14 Imports of food grains from abroad ('000 metric tons)

Year	Food aid	Commercial imports	Total imports
1981-1982	1,141	114	1,255
1982-1983	976	868	1,844
1983-1984	1,441	615	2,056
1984-1985	1,306	1,287	2,593
1985-1986	1,087	113	1,200
1986-1987	1,425	342	1,767
1987-1988	1,787	1,130	2,917
1988-1989	1,356	780	2,136
1989-1990	949	584	1,533
Growth rate (1981-1990) (%)	1.28	10.18	2.6
1990-1991	1,540	37	1,577
1991-1992	1,414	150	1,564
1992-1993	735	448	1,183
1993-1994	654	312	966
1994-1995	935	1,633	2,568
1995-1996	738	1,689	2,427
1996-1997	618	349	967
1997-1998	549	1,402	1,951
1998-1999	1,235	4,256	5,491
1999-2000	870	1,234	2,104
2000-2001	491	1,063	1,554
2001-2002	509	1,289	1,799
Growth rate (1990-2002) (%)	-6.68	26.15	4.32
Growth rate (1981-2002) (%)	-4.3	7.83	0.78

Source: GOB (2003).
Note: Growth rates have been calculated by fitting semi-logarithmic trend lines.

Table A.15 Number of varieties developed for CGPRT crops and their potential yield

Name of the crop			Number of varieties developed by BARI	Potential yield (Ton per hectare)
Bengali name	English name	Scientific name		
Bhutta	Maize	Zea mays L.	11	5.0-8.5
Job	Barley	Hordium vulgare L.	4	2.0-3.0
Cheena	Proso millet	Penicum miliceum L.	1	2.5-3.0
Kaon	Foxtail millet	Citera italica	3	2.0-2.5
Masur	Lentil	Lens culinaris Medic.	4	1.5-1.8
Moong	Mungbean	Vigna radiata L.	5	0.9-1.5
Chola	Chickpea (gram)	Cicer arientinum L.	8	1.3-2.0
Fellon	Cowpea	Vigna unguiculata L.	2	1.1-1.4
Mashkalai	Black gram	Vigna mungo L.	3	1.4-2.0
Kheshari	Lathyrus	Lathyrus sativus L.	2	1.4-1.6
Alu	Potato	Solanum tubersum L.	18	25.0-35.0
Misti alu	Sweet potato	Ipomoea batatas	5	35.0-45.0

Source: Bangladesh Agricultural Research Institute.

Table A.16 Socio-economic characteristics of farmers producing CGPRT crops

Characteristics	Maize	Cheena	Kaon	Lentil	Mungbean	Potato	Sweet potato
1. Farmers age (year)	37	45	46	42	39	43	44
2. Education (% of respondents)							
Illiterate (%)	15	33	40	28	17	14	43
Literate (%)*	85	67	60	72	83	86	57
3. Main occupation (% of respondents)							
Agriculture	90	100	100	92	92	94	100
Service	0	0	0	4	3	1	0
Business	10	0	0	5	5	5	0
4. Land ownership (ha/farm)							
Farm size	0.89	0.92	0.56	1.46	1.49	0.87	1.70
Cultivated land	0.79	0.90	0.45	1.28	1.33	0.76	1.51
Area under CGPRT crops	0.26	0.34	0.21	0.33	0.28	0.51	0.37
Per cent of cultivated land under CGPRT crops	32.91	37.78	46.67	25.78	21.05	67.10	24.50

Source: Field survey.
* Primary and above level.

Appendix B. Basis of Calculation for Requirements and Availability of Livestock Feed

Straw:

Requirements: Each large ruminant requires 2 kg of straw per day. Total requirement for 22.29 million cattle and buffalo for 365 days = 16.27 million mt.

Availability:

(a) Paddy: Paddy straw = 100: 100 = 38.77 million mt
(b) Wheat: Wheat straw = 100: 100 = 1.85 million mt
(c) Pulses: Pulses = 100: 100 = 0.4 million mt

Total availability of straw = 41.02 million mt

Note: After making a deduction of 50 per cent for wastage and other uses, only 20.51 million mt is available as animal feed.

Surplus: 26.02 per cent

Green fodder:

Requirements:

(a) Each large ruminant requires 8 kg of green fodder per day. Total requirement for 22.29 million large ruminants for 365 days = 65.09 million mt.

(b) Each small ruminant requires 1 kg of green fodder per day. Total requirement for 14.61 million of small ruminants = 5.33 million mt

Total requirement for green fodder = 70.42 million mt.

Availability:

(a) Weeds	17.8 million mt (1 ton per acre)
(b) Green grass	0.02 million mt (from formal cultivation)
(c) Wayside grass	1.0 million mt (5 tons per acre from 0.02 million km wayside, assuming 10 acres of grass land per km.
(d) Water hyacinth	4.32 million mt (3.6 ton DM per acre from 12 million acres, assuming 10 per cent water areas under water hyacinth)
(e) Banana waste (leaves and skins)	0.424 million mt (85 per cent of production)
(f) Mango waste	0.004 million mt (20 per cent of production)
(g) Jackfruit waste	0.01 million mt (50 per cent of production)
Total fodder production:	23.579 million mt
Deficit:	66.51 per cent

Appendices

Concentrates:

(a) Requirements: Each large ruminant requires 3 kg of concentrates per day. Total requirement for 22.29 million large ruminants for a year = 24.41 million mt
(b) Each small ruminant requires 200 grams of concentrates per day. Total requirement for 14.61 million goats and sheep for a year = 1.07 million mt
(c) Each poultry/duck requires 65 grams of concentrates (grain and protein concentrates; 50 per cent each) per day. Total requirement for 126.67 million rural birds a year = 3.61 million mt. Assuming 50 per cent of feed is to be gathered under a scavenging system, the total requirement is reduces to 1.5 million mt.
(d) Total requirement of concentrates for 31.67 million commercial poultry = 0.75 million mt (65 grams per day per bird).

Total requirement for concentrates = 27.73 million mt.

Break-up of concentrates requirement

Rice/Wheat bran: Each large ruminant requires 1.5 kg of rice/wheat bran per day. Annual requirement for 22.29 million large ruminants = 12.20 million mt

This figure increases to 15.37 million mt when 3.17 million mt of concentrates required for small ruminants and birds are added.

Khesari: 0.5 kg khesari per large ruminant per day. Thus annual requirement = 4.07 million mt

Oil cake: 0.5 kg per large ruminant per day. Thus annual requirement = 4.07 million mt

Molasses: 0.5 kg per large ruminant per day. Thus annual requirement = 4.07 million mt.

Total requirements for concentrates = 27.58 million mt.

Availability:

(a) Rice bran/polish = 1.51 million mt (6 per cent of grains)
(b) Wheat bran = 0.04 million mt (2 per cent of grains)
(c) Pulse bran = 0.12 million mt (30 per cent of grains)
(d) Oil cake = 0.32 million mt (70 per cent of seeds)
(e) Molasses = 0.09 million mt (3.76 per cent of crashed sugarcane)
(f) Industrial feed = 0.71 million mt

Total concentrate available = 2.79 million mt
Deficit: 89.94 per cent

Source: Calculated by using Haye (1985), Howlider (1999), Saadullah and Hossain (2000), Khan and Husain (2001) and author's own observations.

Appendix C. Description of Areas Surveyed

Kurigram

Kurigram district is situated between 25°18´ and 25°14´ north latitude and between 89°28´ and 89°54´ east longitude. It is bounded on the north by India, on the south by Gaibandha and Jamalpur districts, on the east by India and on west by Rangpur, Lalmonirhat and Gaibandha districts. It occupies an area of 2296 sq. km. The soil type is gray, silty and clay loam. The climate of the district is moderate with equable temperature, high humidity and plenty of rainfall. The average maximum temperature recorded in the district during summer is 35.3°c while the average minimum temperature in winter is 10.7°c. The annual rainfall recorded in 1996 was 2036 millimeters. This district produces varieties of crops namely local and HYV paddy, wheat, millets, jute, sugarcane, pulses, vegetables, oilseeds and other minor crops.

Noakhali

Noakhali, a deltaic district is situated at the fringe of the Bay of Bengal. It is bounded on the north by Comilla, on the east by Feni, on the west by Laxmipur and on the south by the Bay of Bengal. It has an area of 3601 sq. km. The soil of the district has alluvial sediments of recent origin with admixture of sand and clay in varying proportion. The climate of the district is relatively moderate due to its proximity to the Bay of Bengal. The district has a uniform temperature, high humidity and heavy rainfall, which occur from June to October. The average annual temperature varies from 14.6°c to 33°c. This district produces varieties of crops, namely local and HYV rice, vegetables, spices, oil crops, pulses, tubers, betelnut, coconut and others.

Munshiganj

Munshiganj district lies between 23°29´ and 23°45´ north latitude and between 90°10´ and 90°43´ east longitudes. The district is bounded on the north by Dhaka and Narayanganj district, on the east by Comilla and Chandpur district, on the west by Dhaka and Faridpur district and on the south by Shariatpur and Madaripur districts. The total area of the district is 954.96 sq km. The soil type of the district is mainly loamy on ridges and clay in basins. The climate of the district is tropical in nature. The maximum and minimum mean temperature in the winter and summer vary from 25.8°c to 20.0°c and 34.6°c to 25.6°c respectively. The annual rainfall of the district recorded in 1996 was 2044 mm. There are varieties of crops namely local and HYV rice, jute, vegetables, tubers, oil crops etc. grown in the district. This district is famous for the production of potato and pumpkin.

Pabna

Pabna district lies between 23°48´ and 24°21´ north latitude and between 89°00´ and 89°44´ east longitude. The district is bounded on the north by Serajganj and Natore districts, on the east by Serajganj and Manikganj districts, on the west by Kushtia and Natore districts and on the south by Kushtia and Rajbari districts. The total area of the district is 2371.5 sq km. The soil type of the district is mainly sandy clay and sandy. The climate of the district is temperate and pleasant. The maximum and minimum mean temperature during the winter and summer vary from 24.4°c to 10.6°c and 36.7°c to 25.3°c, respectively. The annual rainfall of the district

recorded in 1996 was 1385 mm. Many varieties of crops namely local and HYV rice, wheat, sugarcane, vegetables, spices, oil crops, pulses, maize and others are produced in this district.

Jamalpur

Jamalpur district lies between 24°42´ and 25°26´ north latitude and between 89°40´ and 90°12´ east longitude. The district is bounded on the north by Kurigram and the Garo hill of meghalay state of India, on the east by Sherpur and Mymensingh districts, on the west by Gaibandha, Bogra and Serajganj districts and on the south by Tangail district. The total area of the district is 2031.98 sq km. The soil type of the western part of the district is silty and sandy and eastern part contains dark gray clay loam. The climate of the district is relatively mild. The maximum and minimum mean temperature vary between 33.4°c to 12°c. The annual rainfall of the district recorded in 1996 was 1620 mm. Many varieties of crops namely local and HYV rice, wheat, sugarcane, sweet potato, vegetables, spices, oil crops, pulses and others are produced in this district.

Jhenaidah

Jhenaidah district lies between 23°13´ and 23°46´ north latitude and between 88°42´ and 89°23´ east longitude. The district is bounded on the north by Kushtia and Rajbari districts, on the east by Magura district, on the west by Chuadanga district and partly by India and on the south by Jessore district. The total area of the district is 1949.62 sq km. The soil type of the district is silty, clay loam and loamy. The climate of the district is generally marked with tropical monsoon climate. The maximum and minimum mean temperature range between 38°c to 11°c. The annual rainfall of the district recorded in 1996 was 1952 mm. Many varieties of crops namely local and HYV rice, wheat, jute, sugarcane, vegetables, spices, oilseeds, tobacco, maize, pulses and other minor crops are produced in this district.

Rangpur

Rangpur district is situated between 25°18´ and 25°57´ north latitude and between 88°56´ and 89°32´ east longitude. The district is bounded on the north by Nilphamari and Lalmonirhat districts, on the east by Lalmonirhat, Kurigram and Gaibandha districts, on the west by Dinajpur and Nilphamari districts and on the south by Gaibandha district. The total area of the district is 2307.78 sq. km. The soil type of the district is brown clays with iron and modules of carbonate of lime and clay and soft sandy loam. The climate of the district is mild. The average maximum temperature in summer is 35.30°c and minimum temperature in winter is 10.7°c. The annual rainfall of the district recorded in 1996 was 2036 mm. Many varieties of crops namely local and HYV rice, wheat, jute, potato, vegetables, spices, tobacco, pulses, oil crops, maize and other minor crops are produced in this district.

Kushtia

Kushtia district lies between 23°42´ and 24°12´ north latitude and between 88°42´ and 89°22´ east longitude. The district is bounded on the north by Rajshahi, Natore and Pabna districts, on the east by Rajbari district, on the west by Chuadanga, Meherpur and Partly by India and on the south by Jhenaidah district. The total are of the district is 1621.15 sq. km. The soil condition of the district is predominantly clay. The climate of the district is moderate. The maximum and minimum mean temperature range is between 34.7°c to 11°c. Annual rainfall of the district recorded in 1996 was 1752 mm. Many varieties of crops namely local and HYV rice,

wheat, jute, sugarcane, vegetables, spices, pulses, oilseed, tobacco and other minor crops are produced in this district.

Lalmonirhat

Lalmonirhat district is situated between 25°46´ and 26°33´ north latitude and between 89°01´ and 89°36´ east longitude. It is bounded on the north by India, on the south by Gaibandha and Jamalpur districts, on the east by India and Kurigram and on the west by India and Nilphamari district. It occupies an area of 1241.46 sq. km. The district is covered by non-calcareous gray sandy and gray and brown silty clay loamy soil. The climate of the district is moderate with equable temperature, high humidity and plenty of rainfall. The average maximum temperature recorded in the district during summer is 35.3°c while the average minimum temperature in winter is 10.7°c. The annual rainfall recorded in 1996 was 2036 millimeters. This district produces a variety of crops namely local and HYV paddy, wheat, maize, jute, sugarcane, pulses, vegetables, oilseed, tobacco, spices, betel leaves and other minor crops.

Manikganj

Manikganj district lies between 23°38´ and 24°03´ north latitude and between 89°41´ and 90°16´ east longitude. The district is bounded on the north by Tangail and Serajganj districts, on the east by Dhaka, on the west by Pabna, Rajbari and Serajganj districts and on the south by Dhaka and Faridpur district. The total area of the district is 1379 sq. km. The soil of the district is formed by silty and sandy loam soil. The climate of the district is relatively mild. Many varieties of crops namely local and HYV rice, wheat, maize, sugarcane, sweet potato, vegetables, spices, oil crops, pulses and others are produced in this district.

Comilla

Comilla is located in the middle east belt of the country between 23º03´ and 23º48´ north latitudes and 90º38´ and 91º22´ east longitude. The district is surrounded on the north by Brahmanbaria district, on the east by Indian Province of Tripura, on the west by Chandpur, Munshiganj and Narayanganj district and the south by Noakhali and Feni districts. The total area of the district is 3085 sq. km. The greater part of the district consists of alluvial soil watered by numerous rivers and streams. The climate of the district is moderate with temperature ranging between 33.5ºC and 11.8ºC. The main crops of the district are rice, wheat, millets, jute, sugarcane, pulses, vegetables and oil seeds.

Brahmanbaria

Brahmanbaria is located between 23º39´ and 24º16´ north latitude and between 90º44´ and 91º51´ east longitude. The district is bounded on the north by Kishoreganj and Habiganj district, on the east by India and Habiganj district, on the south by Comilla district and on the west by Kishoreganj, Narsingdi and Narayanganj district. It has a total area of 1927.11 sq. km and constitutes 1.31 per cent of the total area of the country. The soils of the district are of gray silty loam, dark gray clay and silty clay loam type. The main crops of the district are rice, jute, wheat, millets, sugarcane, vegetables, pulses and oil seeds.