

POLICY OPTIONS FOR SUPPORTING AGRICULTURAL DIVERSIFICATION IN BANGLADESH



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ABBREVIATIONS

AD	=	Agricultural Diversification
ADI	=	Agricultural Diversification Index
APP	=	Agricultural Perspective Plan
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
BCR	=	Benefit Cost Ratio
BFRI	=	Bangladesh Fisheries Research Institute
BINA	=	Bangladesh Institute of Nuclear Agriculture
BJRI	=	Bangladesh Jute Research Institute
BLRI	=	Bangladesh Livestock Research Institute
BRRI	=	Bangladesh Rice Research Institute
CDP	=	Crop Diversification Programme
CGPRT	=	Coarse Grains, Pulses, Roots and Tubers
CIDA	=	Canadian International Development Agency
CIP	=	Country Investment Plan
DAE	=	Department of Agricultural Extension
DAM	=	Department of Agricultural Marketing
DLS	=	Department of Livestock Services
DoF	=	Directorate of Fisheries
DRC	=	Domestic Resource Cost
EPC	=	Effective Protection Co-efficient
ERP	=	Effective Rate of Protection
FFYP	=	Fifth Five Year Plan
GDP	=	Gross Domestic Product
GLS	=	Generalized Least Square
GoB	=	Government of Bangladesh
GoN	=	Government of Netherlands
GR	=	Gross Return
HIES	=	Household Income and Expenditure Survey
HVC	=	High Value Crops
HYV	=	High Yielding Variety
ICT	=	Information and Communication Technology
MoA	=	Ministry of Agriculture
NAP	=	National Agricultural Policy
NFPCSP	=	National Food Policy Capacity Strengthening Programme
NFPPA	=	National Food Policy Plan of Action
NGO	=	Non-governmental Organization
NPC	=	Nominal Protection Co-efficient
NRP	=	Nominal Rate of Protection
PCC	=	Per Capita Consumption
SDI	=	Simpson Diversity Index
SFYP	=	Sixth Five Year Plan
ToR	=	Terms of Reference
USAID	=	United States Agency for International Development

Acronyms

<i>Aus</i>	=	Pre monsoon rice
<i>Boro</i>	=	Irrigated rice in winter season
<i>Kharif-I</i>	=	Early monsoon cropping season (16 March to 15 July)
<i>Kharif-II</i>	=	Monsoon cropping season (16 July to 15 October)
<i>Rabi</i>	=	Winter cropping season (16 October to 15 March)
<i>T. Aman</i>	=	Transplanted monsoon rice

Executive Summary

1. Background and Rationale

Agricultural diversification (AD) towards products with a higher value-added contributes to more rapid agricultural income growth and employment. Diversification in production is also likely to lead to diversification in consumption, which is required for healthier and more balanced diets.

The rapid growth in domestic demand for fruits, vegetables, dairy products, fats and oils is also creating new opportunities for diversification of agricultural production beyond cereals. Cereal expenditure as a percentage of total expenditure declined from 28.87% to 28.41% in urban areas and from 41.23% to 39.62% in rural areas between 2000 and 2010. In contrast, during the same period expenditure for fruits rose from 4.10% to 5.29% and from 2.59% to 3.49% in urban and rural areas, respectively. Similarly, the consumption expenditures for fish, meat & eggs and spices rose between 2000 and 2010 at national level from 12.48% to 13.71%; 8.02% to 10.31% and 7.13% to 9.99% respectively.

Between 1998-1999 and 2007-2008, the value of rice, fruits, vegetables and inland fish output in Bangladesh rose by 2.3%, 10.5%, 7%, and 4.5% per year, respectively. Again, the value of pulses production fell by 1.6% and oilseeds production value increased only slightly by 1.7% per year during the same period, which resulted in large imports of pulses and oils to meet growing demand. By way of comparison, India witnessed a 2.3% rise in value of both rice and fish output during 1996-1997 to 2001-2002, while the value of pulses and oilseed production dropped by 2.6% and 3.9%, respectively.

Much emphasis was given in the Sixth Five Year Plan (2011-2015) to attain self-sufficiency in food grain production along with increased production of other nutritional crops, as well as to encourage the export of vegetables and fruits keeping in view domestic production and need (SFYP, 2011). Besides, national policy documents including NFPPA (2008), NAP (2010), CIP (2011) recognize the need for diversifying agricultural production. Although it is generally understood that factors such as climate and market risks, agro-ecological characteristics, tenure rights and access to inputs influence the ability to diversify, sufficiently specific evidence for informing policy interventions is not available.

Through an analysis of various data sources and the collection of primary data, the study will identify specific factors that constraint and support different types of agricultural households across the country in diversifying their agricultural production. On the basis of this analysis concrete policy options for facilitating agricultural diversification will be provided.

Objectives of the Study

- a. To assist policy makers in identifying policy interventions that will allow agricultural households to diversify their agricultural production into micro-nutrient rich foods and/or those with a strong income generating potential.
- b. To examine past trends of diversification of crop and non-crop agriculture, and compare the rates of growth to those in neighbouring countries to gain some perspective on how rapid (or slow) growth in Bangladesh has been.
- c. To examine socioeconomic and agro-climatic determinants of and constraints to agricultural diversification.

Key Research Questions

- a. What are the past trends of acreage and production of major food commodities and to what extent they differ from the trends of neighbouring countries like India and Pakistan?
- b. What are the changes in the consumption of different food commodities and how they are related to domestic food production?
- c. What changes have been taken place in financial and economic profitability of different food commodities over time and how they affect their production?
- d. What are the constraints to and opportunities for agricultural diversification in Bangladesh?
- e. What are the determinants of agricultural diversification in Bangladesh?

2. Past Crop Diversification Initiatives in Bangladesh

In its efforts to attain self-sufficiency in food production to feed a growing population since 1972, the government of Bangladesh (GoB) has promoted cereal crop production with the introduction of HYV of rice and wheat and by launching Green Revolution and Grow More Food programmes. As a result of these initiatives, cereal crop production has increased tremendously, but land allocation and yields for minor crops, such as pulses, oilseeds, vegetables, fruits and spices, has decreased. Despite the policy emphasis on cereals, demand for minor crops increase and the government expended valuable foreign exchange to import them. To ensure the success of the diversified cereals policy, large quantities of fertilizers were imported to improve the nutrient status of soil.

In 1989, realizing the importance of growing minor crops, the government launched the Crop Diversification Programme (CDP), which was undertaken jointly by the GoB, the government of Netherlands and Canada's International Development Agency. Crops included in the programme were tubers (potato, sweet potato, aroid), oilseeds (rapeseed, mustard, groundnut, sesame, sunflower, and soybean) and pulses (lentil, blackgram, mungbean, chickpea, fieldpea, cowpea, and pigeon pea).

Although diversification remained low, CDP has showed positive impacts on the production of minor crops. The production of potato, oilseeds, pulses, fruits and vegetables increased in those areas under the programmes as compared to the non-CDP areas. The level of crop diversity increased by 4.5% over the 36-year period from 1960 to 1996, when the two agricultural censuses were conducted. There was a modest increase in potato production, which was attributed to growth in acreage and yield. The yields of pulses and oilseeds increased due to the adoption of improved production technologies.

Each CDP crop experienced a different set of problems. However, the Ministry of Agriculture (2000) identified some common constraints for promoting crop diversification. These constraints were non-availability of suitable land; non-availability of water and technology packages; low adoption rate of new varieties; imports of pulses and edible oils as disincentives to diversification; and lower price of CDP crops.

3. Methodology of the study

The study used both primary and secondary data and information. The main categories of information used in this study were: (i) Synthesis of relevant findings from existing literature;

(ii) Secondary data and information from available sources; and (iii) Primary data and information obtained from sample survey.

In order to examine the agro-socio-economic determinants of and constraints to agricultural diversification at household/micro level, three sub-sectors namely crop, livestock and fisheries were considered in this study. According to ToR, the growth rates of the area and production of 21 crops and non-crop enterprises were estimated using fifteen years time-series data. Based on these growth rates, 10 fast-growing crop and non-crop enterprises including maize were selected for the study

Multi-stages sampling procedure was followed to select sample study areas for farm survey. In the first stage, two surplus districts for each selected product were selected for farm survey. In some cases, a surplus district has been represented for more than one product. A total of 12 districts were selected. The area and production of all the selected products were collected from *Upazila* Department of Agricultural Extension (DAE) office over telephone. Based on the highest area and production, two *Upazilas* from each district were selected for studying one product. Thus, a total of 40 *Upazilas* were selected for 10 selected products. Practically this number was less when one *Upazila* represent for more than one product. The final stage of sampling was agricultural block. From each of the selected *Upazilas*, one agricultural block was selected in consultation with DAE personnel. The selected blocks were used for gathering primary data and information from the farm households engaged in producing selected 10 products along with other crops. The criterion for selecting farm households was the ranking based on volume of production of selected products. Accordingly, a total of 600 farm households taking 15 households from each block who were involved in producing the selected products were selected for interview. Again, the survey covered a total of 360 farm households (i.e. taking 30 households from each district) who were not involved in growing selected products and mostly involved in growing rice and wheat. Thus the total sample size was 960.

In order to formulate suitable policy guidelines for agricultural diversification, the study reviewed the existing status of financial and economic profitability of agricultural productions, agricultural incentives, and the comparative advantage of cultivating agricultural commodities by using scarce resources. Data and information in this purpose were collected from national research institutes, public universities, research publications of FAO, and journal articles.

The study analyzed the trend and annual growth of area, production and yield of different crop and non-crop enterprises by regions of Bangladesh using time-series data (1990 to 2009) from Bangladesh Bureau of Statistics (BBS). Decomposition analysis was also done to find out the sources of growth. Besides, the trends and growth rates of area, production and yield of major food commodities of Bangladesh were compared with the trends and growth rates of those in neighbouring countries like India and Pakistan for gaining some perspectives on how rapid (or slow) growth was occurred in Bangladesh. The statistics of Food and Agricultural Organization (FAO) were used in this purpose.

The consumption pattern in Bangladesh has changed over the years due to various reasons. Therefore, the study analyzed the consumption pattern of different food commodities and its changes over the time through analyzing time series and various HIES data from BBS. It also analyzed time series data on major food commodity production, export and import from FAOstat to estimate the net consumption. Diversification in consumption was also measured in different ways.

The pattern and extent of Agricultural Diversification (AD) and inter-linkage effects were examined both at macro and micro levels. The overall AD was examined in terms of diversity

of both crop and non-crop agricultural activities. The determinants of AD were examined both at the macro and micro levels using district panel data and primary household data respectively. Probit model and Generalized Least Square (GLS) regression model were used to measure AD at the micro and macro levels respectively. The constraints and opportunities for AD in Bangladesh were also explored. A typical farm generally found in the rural areas was organized in such a way that a number of crop and non-crop enterprises were confined to constitute a farming system. All these aspects were examined in this study by utilizing the micro level data which were collected through farm survey.

Bangladesh is a net importer of most food commodities including cereals and non-cereal commodities. The study analyzed the growth performance of international trade for selected food commodities in Bangladesh and compared those with neighbouring countries India and Pakistan. Data and information regarding this aspect were collected from FAOstat and BBS publications. Trade diversification was measured in different ways.

4. Profitability and Comparative Advantage of Major Commodities Production

A basic tenet of this study is to test the profitability of farming various crops and non-crops enterprises, and understand their contribution to income of the farm household. Hence, it reviewed the existing status of financial and economic profitability of agricultural productions, agricultural incentives, and the comparative advantage of cultivating agricultural commodities by using scarce resources.

Financial profitability: From the financial point of view, the existing literature indicates that the production of all crops and non-crop enterprises are profitable to the farmers since the benefit cost ratios (BCR) of all the commodity production are greater than unity. The profitability of most non-cereal crop production is higher than that of cereal production. Perennial fruit productions are the most profitable followed by oilseed and spices, non-cereal crops, and fisheries. Livestock and poultry are among the least profitable agricultural commodities with BCR barely crossing one (so is rice). The productions of fruits and spice crops are more profitable compared to other crops and non-crop enterprises and this might be due to government subsidy on interest to farmers producing spices.

Economic profitability: The economic profitability of cultivating crops in Bangladesh deviates from financial profitability due to various reasons including distortion in input and output markets, externalities, and government policy interventions. The economic returns of HYV rice cultivation were much higher at import parity price (Tk.10763-Tk.19970/ha), but much lower than its corresponding financial returns at export parity price (Tk.3428-Tk.9644/ha). The economic profitability of jute (Tk.11140/ha) and tobacco (Tk.91212/ha) at export parity level was much higher than its financial returns. Whereas, the economic profitability of sugarcane (Tk.33323/ha) and cotton (Tk.16886/ha) at import parity level was lower than its financial returns. Oilseed crops showed negative economic returns at import parity price (Tk.-597-Tk.-6463), but financial profitability of these crops were positive. The economic profitability of pulses was higher compared to financial profitability at import parity price level (Tk.8551-Tk.14543/ha). The economic profitability of chili (Tk.6549/ha) and onion (Tk.86322/ha) was positive, but much lower than their financial returns at import parity level. Because of higher domestic prices, chili is highly competitive with other *Rabi* crops. The economic profitability of potato was much higher at import parity basis (Tk.184665/ha) than the price measured at export parity (Tk.26788/ha) level. Other vegetables appeared to be highly competitive in terms of both financial and economic returns. The economic profitability of vegetable production for export appears to be amazingly high (Tk.194865-Tk.553940/ha) as compared with most other crops.

Impact of policy on agricultural incentives: A Nominal Protection Coefficient (NPC) of greater than one indicates that the government has protected domestic production by raising its financial price in the domestic market above its economic price. Rashid et al. (2009) showed that the NPCs estimated at import parity level were 0.953, 0.362 and 0.463 for coarse rice, aromatic fine rice and non-aromatic fine rice production during 1990 respectively. On the other side, the NPCs estimated at export parity level were 1.046, 0.449 and 0.644 for the corresponding above rice production respectively. It means that domestic rice production was taxed and consumers were subsidized. Rashid et al. (2009) also showed that the border price of wheat, maize, potato and lentil at producer level measured at official exchange rate was mostly higher than the domestic producer price. It means that there is scope of producing these crops for import substitution and export promotion.

Comparative advantages crop production: A Domestic Resource Cost (DRC) ratio of less than one implies that the production is efficient and makes positive contribution to domestic value added. Rashid et al. (2009) estimated DRC for rice, wheat, maize, potato and lentil production for the period of 2005 to 2009 at import and export parity prices and found DRCs less than unity under both import and export parity prices implying that the country had comparative advantage in producing these crops for import substitution and export promotion. Karim et al. (2011) also estimated DRCs of producing thirteen vegetables using f.o.b. prices at airport and found DRC values less than unity for all vegetables indicating that the country had comparative advantage in vegetable production for export promotion.

5. Growth Performance of Major Crops

Detailed growth analysis revealed that the highest and impressive growth performances have been observed in maize crop (i.e. area 25.4%, production 37.9%, and yield 12.5%) among cereal crops during 1990-2009. But, the overall growth performance of *Boro* rice (i.e. area 3.6%, production 6.0%, and yield 2.4%) is better than other rice crops. Although the growth rates (GR) of area and production of various pulse and oilseed crops are negative (Pulses: -4.0% to -15.5%; oilseed: -0.8% to 2.3%), the growth rates of yields are positive (Pulses: 0.5% to 4.9%; oilseed: 1.5%) due to adoption of improved technologies. The overall growth performances of onion (i.e. 3.0% to 10.0%) and garlic (i.e. 2.3% to 7.4%) are found to be excellent among spices crops. On the other side, the growth rates of area (0.3%), production (1.5%) and yield (1.2%) of mango show impressive performance compared to other fruits. Among vegetable crops, the overall growth rates of area (7.1%) and production (9.5%) of potato, pointed gourd (GR of area 5.7%, production 7.6%; yield 1.9%) and okra (GR of area 5.3%, production 6.6%; yield 1.3%) have been found impressive.

Decomposition analysis reveals that changes in cropped area was the principal contributor to change in the mean productions of *Aus*, *Boro*, maize, vegetables, pulses, mustard, banana, jackfruits, onion and garlic at national level during 1990-2009. Again, the main source of change in mean productions of Aman rice, wheat, groundnut, mango, turmeric, chili, and ginger at national level was due to change in mean yield of these crops.

6. International Comparative Growth Performance of Major Food Commodities

The growth rates of area, production and yield of selected commodities were analyzed for Bangladesh, India and Pakistan. Comparative growth performance scenario reveals that the overall growth performances of rice and wheat were admirable for Pakistan compared to Bangladesh and India. Excellent growths in area, production and yield of maize were found in Bangladesh. The overall growth performance of mango and papaya were observed in India and Bangladesh respectively. Although the growth rates of area and production of pulses were negative for three countries, productivity growth rates were found positive due to adoption of

improved technologies. In Bangladesh, the overall growth rates of oilseeds were impressive but it was negative for India. The growth performances of vegetables, potato, egg and mutton were found inspiring for Bangladesh compared to other two countries. Fisheries sector also performed better both in Bangladesh and Pakistan.

7. Diversification in Food Consumption

Growth rate of per capita food availability: The highest GR registered in maize availability (36.47%) followed by the availability of egg (12.75%), potato (9.77%), and meat (7.38%) during 1990-2009. The per capita availability of mango, onion, jackfruit, pointed gourd, papaya, sugar and garlic also registered impressive growth rates during that period. The GRs of okra, cabbage, brinjal, cauliflower, and bitter gourd were found to be positive that ranged from 2.20% to 5.14%. Spices like chili, turmeric and ginger also registered positive growth rates. Very little but positive growth rates were observed in the availability of milk & milk products, banana and radish, whereas negative growth rate was for pulses.

Per capita consumption (PCC) of foods by residence: The PCC of major foods in Bangladesh increased from 920 gm/day in 2000 to 1000 gm/day in 2010. This increase was true for rural and urban areas also. The percent share of rice in total food basket declined both in rural and urban areas, while the overall share of wheat increased from 17.24 gm/day in 2000 to 26.09 gm/day in 2010. Sharp increase was taken place in the PCC of potato, edible oil, onion, chicken, egg, fish, milk and fruits both in rural and urban areas during 2000 to 2010. The PCC of vegetables increased in rural areas and mutton consumption increased in urban areas. This increasing trend in consumption may lead to further diversification of crop and non-crop agriculture in future.

Per capita consumption of foods by poor and non-poor: The overall consumption of non-poor people was 24.5% higher than that of poor people. The PCC of livestock products, fruits and fish of non-poor households were much higher (46-87%) than that of poor people. The consumption differences were found less in rice, potato, and vegetables between two groups.

Per capita consumption of foods by land category: The per capita per day consumption of most food items except fruits has decreased to a large extent for marginal, small and medium category farmers in 2010 compared to 2000 and 2005. For large farmers, the consumption of most rich foods such as fish, meat, fruits, and edible oils has considerably increased during this period. But, the level of consumption of cereals, pulses and milk have decreased for large farmers during this period. However, substantial gap remains in the consumption of quality food items such as fish, meat, fruits, and oils between large farmers and other category farmers.

Per capita consumption of foods by lower and upper income group: A substantial gap remained in the consumption of quality food items like meat, fish, milk, fruits and oils between upper and lower income groups. The level of consumption of these food items also remained below the recommended level which is important for healthy and productive life.

Diversification in cereal and energy consumption: A considerable diversification in consumption has taken place in Bangladesh over time. The share of cereal consumption show a decreasing trend over the year (i.e. 0.55% in 2000 and 0.46% in 2010) at all levels. The diversification in cereal food consumption occurred faster in urban areas compared to rural areas.

The calorie intake from non-cereal foods has increased in the country. At national level, the diversification index of calorie intake from cereal consumption ranged from 0.75 in 2000 to 0.69 in 2010. It indicates that calorie intake from non-cereal foods increased in the country and

it was diversified over time. The percent change in the diversification of calorie intake was much lower compared to the percent change in the diversification of cereal consumption. The calorie intake from cereals was higher at the residents of rural areas (71%) compared to the residents of urban (61%) areas in 2010.

8. Diversification in Agricultural Production

Diversification of agriculture in Bangladesh is manifestation of a shift of resources from rice to other cereal crops, from cereals to non-cereal crops, and from crops to non-crop agriculture.

Status of agricultural diversification: The average value of Agricultural Diversification Index (ADI) and its growth rate is 0.56 and 0.77% during 1993-2010 respectively. However, the overall agricultural diversification is showing an increasing trend with fluctuating nature. The regression equation ($y=0.52+0.0043x$) also implies that the AD in Bangladesh is showing an increasing trend. AD also shows a sharp increase that took place in 2007 which was due to the combined effect of sharp increase in the productions and prices of some vegetables, spices, fruits, and fish. The commodities which productions increased in 2007 were groundnut, garlic, turmeric, potato, mango and jackfruit. Again the commodities which prices increased were lentil, mustard, chili, pointed gourd, potato, okra, pineapple and fish.

In the regional context, the highest agricultural diversification took place at Chittagong and Barisal region over the time due to the increase of the productions and prices of some non-cereal commodities mentioned above during 2007. Again, the lowest agricultural diversification took place at Rangpur and Rajshahi region over the years. The percent share of income from cereal crops to the total income was higher than that of the income from non-cereal commodities at Rangpur and Rajshahi region implying a wide scope for diversifying agriculture introducing high value crops and non-crop commodity to the existing agricultural farming in future. However, more or less an inverse relationship was observed between the value of ADI and its growth rate. There is a good possibility of occurring AD in different forms throughout the country considering different Agro Ecological Zones (AEZ) of Bangladesh.

Comparative scenario of ADI: The comparative performance of agricultural diversification reveals that the highest agricultural diversity (78%) was occurred in Pakistan and the lowest (56%) in Bangladesh during 1993-2010. The average value of ADI for Pakistan and India was 38% and 9% higher than that of Bangladesh. Again, the growth performance of agricultural diversification was much better in Bangladesh (0.77%) compared to India (-0.65%) and Pakistan (-0.43%) during 1993-2010.

Factors of agricultural diversification: The diversity of agricultural production is likely to be influenced by different socio-economic factors at household level. Probit regression model reveals that the probability of increasing AD at household level is significantly influenced by irrigated land, agricultural training, extension linkage, heritage in production, and credit facility.

AD in Bangladesh at national level is also influenced by different socio-economic factors. Initially we planned to include 18 variables in the model, but finally we could include only four variables due to unavailability of district level panel data. The results of GLS regression reveals that the probability of increasing agricultural diversification at national level is significantly influenced by real labour wage, per capita road length, rainfall, agricultural credit disbursement, and population.

9. Diversification in Agricultural Trade

Bangladesh is a net importer of most commodities including cereals and non-cereals. Imports of pulses, edible oils, spices and sugar have been rising at an alarming rate. The import bill on account food has grown at more than 10% in the current decade and now accounts for over one-fifth of the export earnings of the country.

Growth rate of food commodities import and export: Bangladesh exports and simultaneously imports rice, edible oils, vegetables and potato and the growth rates of both export (12.8-50.0%) and import (5.7-49.8%) are significantly positive for these commodities during 1990-2009. Again, Bangladesh only imports wheat, maize, pulses, and chicken from foreign countries and their import growth rates were significantly positive. India also exports and simultaneously imports maize, pulses, edible oils, spices, vegetables and potato. Both export and import growth rates were positively significant over the aforesaid period. The growth rates of rice (9.7%) and goat (32.3%) export were significantly positive, whereas it was significantly negative for cattle (-32.2%). Pakistan exports and also imports rice, pulses, edible oils, vegetables and potato. The growth rates of both export and import of these commodities were significantly positive, whereas only export growth rates for wheat (79.4%) and banana (15.0%) were found significant and positive.

Share of net trade: The share of net import of wheat, maize, pulses and oilseeds in Bangladesh ranged from 37.47% to 65.23% of the total availabilities of these commodities. Whereas, these shares ranged from 0.46% to 31.28% for Pakistan. Except pulses, India exported wheat, maize and oilseeds to other countries and the share of export to the total production ranged from 0.39 to 4.04%. India and Pakistan exported 8.75% and 10.98% of their total production of spices to other countries. The share of vegetable export in Bangladesh was 0.11% to its total production. India and Pakistan also imported some vegetables from foreign countries.

Diversification in agricultural trade: Due to increased demand for non-cereal food, Bangladesh imports a huge amount of non-cereals every year. Therefore, a substantial change has already been occurred in agricultural trade over time. India and Pakistan are able to increase their cereal export, but Bangladesh has increased import of cereal over the same period of time. This is despite the fact that both India and Pakistan became more diversified over the same period of time. Bangladesh is less diversified than India and Pakistan – this means that our non-cereal production has not grown as much as that of India and Bangladesh and yet Bangladesh's cereal import has gone up compared to other agricultural imports. This could be either due to population pressure or due to changes in food habit for consumers in Bangladesh. In terms of net growth of population Bangladesh is the least population growth countries in this region. Therefore, positive trend in trade of cereal products (mainly wheat since rice import remained stable) could be due to changes in food habit. Again, there has been a net growth in consumption of wheat in Bangladesh. Therefore, it can be argued that positive trend in cereal trade is due to diversification of our consumption from rice to wheat.

The net import trend of non-cereal agricultural trade over total agricultural trade is negative for Bangladesh, while it is fluctuating for India and unchanged for Pakistan. This means that AD in Bangladesh has reduced our dependence on foreign markets in terms of non-cereal trade. It has not been so either for Pakistan or for India. Consequently, it can be argued that despite lower degree of diversification of agriculture in Bangladesh, it has been able to reduce Bangladesh' dependence of non-cereal products from other countries. This is a positive gain from AD programs. It also shows potential in terms of gains from non-cereal diversification of agriculture in Bangladesh.

10. Constraints to Agricultural Diversification

Problems of diversified crop production: The respondent farmers who cultivated different diversified crops faced various problems during farming. Their problems were linked with three major areas such as production, marketing and social. The major production related problems were infestation of insect and diseases (39%), lack of working capital (25%), low quality feed (18%), lack of HYV seed/sucker/chick/fingerling (17%), higher cost of production (15%), lack of drainage facility (9%), natural calamities (7%), and damage of roots & crops (6%). The major marketing related problems were higher price of feed (56%), higher price of vitamins and vaccine (42%), higher price of fertilizers (29%), lower price of outputs (17%), higher price of pesticides (13%), higher price of seed/ fingerlings/chick (11%), transportation problem (9%), adulteration of fertilizers and higher price of irrigation (8%). Finally, the scarcity of labour and its higher price (29%), load shading of electricity (18%), stealing of fruits (8%), and lack of training (4%) were associated with social problems.

Constraints to agricultural diversification: Non-diversified farmers were asked why they did not cultivate diversified crops in order to understand their opinion about the constraints of agricultural diversification in the study areas. The major constraints to agricultural diversification were lack of suitable land/land far away (45.3%), lack of own and sufficient capital (44.25), scarcity of labour and its higher price (26.4%), higher cost of production (24.7%), lack of fair price of the produces (17.5%), lack of training facility (9.2%), infestation of insects and diseases (8.9%), higher price of fertilizers (8.3%), and required higher labour (8.1%).

11. Recommendations

Based on these assessments and based on the field observations, the following recommendations are summarized.

Reorganizing the Department of Agricultural Extension (DAE): There shall be a change in the institution of extension services in Bangladesh. Farmers with more extension contacts are found to be more diversified than others and so it is important that the DAE needs to reorganize itself to ensure more contacts. DAE also needs to re-orient its extension workers to support growing extension needs for non-cereal agricultural products like spices, fruits, vegetables, poultry, fisheries and livestock.

Facilitate agricultural credit to farmers: An agricultural credit is an important factor for diversification of agriculture. Farmers with access to credit facilities are found to be more diversified than others. This is an important finding of this study. This means credit facilities need to be extended to farmers. The current government, for the first time, ensured that farmers have a bank account in a bank in order to facilitate payment of subsidy to them. While the endeavor is a great one its outreach is very limited. In addition, farmers do not receive banking services like other normal customers of the bank. This limits their ability to use banks as the right tool to do transactions. Given the access to mobile networks, government should extend BKASH or mobile banking services to farmers to access credits.

Investment in transportation networks: Access to market is found to be less important at the farmers' level but it is important for increasing diversity in agriculture regionally. This means, a district with better communication and transportation facilities are more diversified than other regions. Most of the non-cereal produces are perishable items and so means of transportation and access to the market is important for them. Ironically, storage at the local level was not found to be an important variable. This is due to the fact that when access to roads is ensured, storage facilities become less important and it can be provided through

private investment. Therefore, investments in public transportation of vegetables, fruits, etc. are important elements to promote agricultural diversification.

Training for farmers: Modern agricultural is much more challenging than before. There are elements of production, processing, storage and transportation and in all of them training is an important pre-condition for ensure higher profit to a farmer. Training includes: a) training in production technologies, b) training in harvesting technologies, c) training in processing and storages, and d) training in packaging for transportation.

To promote non-cereal diversification in agriculture, DAE should organize itself to ensure farmers' level training programs – or farmers' summer school instead of concentrating only on IPM technologies.

Irrigation infrastructure for non-cereal producing farmers: In the 1970s investment in irrigation infrastructure lead to green revolution in terms of cereal production. Trends in demand suggest that demand for fruits, vegetables, spices, edible oil, meat and fish are on the rise both for poor and non-poor households. This means a new generation of investment in irrigation technology which will meet needs of the future non-cereal farming population. This means switching towards drip-irrigation, piped-irrigation, instead of promoting the current flood irrigation techniques.

Access to better irrigation technology will not only reduce water requirement for agriculture, it will also allow farmers to choose crops other than rice and wheat. The new generation irrigation technology should be less labor intensive.

Promoting better access to market: Maize production has been growing at a very fast rate in Bangladesh and it is mainly due to ready market for its output. This is due to the fact that poultry producers are many and spread-out throughout the country. The market is not manipulated, or influenced by non-market forces. As a result farmers enjoy higher profitability. Similarly it is true for fruits and vegetable markets. It is therefore, important that government regulation towards market shall be limited to incentives.

At the same time, each layer of the market-chain should be free from manipulation by their agents and so access to markets by the farmers through 'farmers market', village hut, be ensured. Once the direct entry into the market is cut-off through regulation of market players like who can enter in a market and who cannot often reduces profitability. Therefore, farmers should be given an inherent right to sell their products directly to the customers and for this government should develop markets only for them at a local level. The concept of 'village hut' that used to run twice a week could be introduced in all small townships where sellers must be a farmer.

Risk reduction strategy: Price uncertainties in input and output are a potential threat against farmers moving out of cereal crops. These uncertainties shall be dealt with. There are several strategies for this: a) certification of products and seeds; b) quality assurance of inputs; c) development of liability rules for failures due to low quality input; d) government procurement rule with known principle of price; and e) supply of credits with reduced interest or other inputs at reduced prices. Government should analyze these policies and develop a comprehensive strategy to induce diversification of agriculture.

Institutional reforms: AD means both crop and non-crop agricultural production. At the moment the DAE is completely separate from other departments like livestock, fisheries and poultry extension services. All these services are not equally accessible in every region of the

country. As such agricultural diversity cannot speed up. Farmers need a one stop service for all. This requires a complete re-thinking of our current DAE.

Development of new technologies: Most farmers cannot harvest the benefit of diversification due to low yield of diversified commodities which is the result of cultivating local cultivar of these commodities. In order to promote the diversification with diversified commodities, investment should be directed to reduce yield fluctuation by developing improved technologies including new variety, off-season variety, stress-tolerant and resistant varieties of these crops. The national agricultural research institutes should make efforts to develop improved varieties and production systems with comparative advantage, of fruits, vegetables, spices, livestock, poultry and fish to open up new opportunities for farmers.

Encourage farm mechanization: The shortage of farm labourer is currently a common phenomenon in agriculture due to the expansion of non-farm employment opportunities with higher wage throughout the country. It creates various problems in the process of production and marketing of diversified crops. Therefore, farm mechanization should be encouraged in various agricultural activities for combating the impending labour shortages, minimizing the cost of production, reducing the turn over period of cultivation, augmenting farmers' income, and conserving natural resources.

INTRODUCTION

1.1 Background

Agricultural diversification (AD) implies a shift of resources from primary staple crop, namely rice, to other cereal crops, from cereals to non-cereal crops, and from crops to non-crop (livestock, fisheries and forestry) agriculture. It has been used around the world as a strategy to minimize risk (Freund, 1956), minimize income variability over seasons (Jones, 1950; Heady, 1952), optimize the use of land and other resources (Heady, 1952), change the food habit, increase protein intake, improve food security, promote exports, substitute imports, conserve natural resources, create employment opportunities and alleviate poverty for the farming household (Alam, 2005).

In order to feed the ever increasing population, the government of Bangladesh emphasized cereal crop production with the introduction of high yielding varieties (HYVs) of rice and wheat since independence. As a result, production of major cereal crops increased tremendously, but the production of minor crops (i.e. oilseeds and pulses) declined gradually and failed to keep pace with the rapid population growth. Therefore, the government was compelled to import a substantial amount of minor crops to sustain and improve the nutritional status of the people. In addition, more intense rice and wheat production lead to depletion of soil fertility and hence farmers usually compensate it with doses of fertilizer. This leads to higher import of fertilizers, or more specifically use of nitrogen additives to soil, leading to increased pressure on our limited foreign exchange reserve.

Minor crops, especially pulse crops, are important sources of protein and calorie and have also a positive impact on the nutrient balance of the soil (Islam, 1991). In many cases, farmers can easily cultivate these crops at low cost after harvesting their major crops. With this realization, the government launched a crop diversification programme (CDP) in 1989 to enhance the production of minor crops. The effect of CDP on minor crops production was slightly positive while there was a decline in acreage (Alam, 2005). Low growth in production is mainly attributed to limited availability of extension services in these crops.

Recent data shows that imports of minor agricultural products including spices and fruits have increased due to rapid growth in domestic demand and so there is a need to revisit the overall policy related to non-cereal crops and other agricultural products in the country. In addition, it would be also meaningful to conduct a much more in-depth analysis of past government initiatives in order to promote agricultural diversification programs. Results of these studies could be used to develop policies for agricultural diversification in Bangladesh. This study is an attempt in this direction.

1.2 Arguments Towards Policy Support

Agriculture is still one of the most important sectors of the economy of Bangladesh and contributes 20.16% to the gross domestic product (GDP) while 51.33% of households are engaged in this sector (BBS, 2010). This sector comprises crop, livestock, fisheries and forestry sub-sectors accounting for 55.7%, 13.24%, 22.37% and 8.68% of agricultural GDP respectively. Although the overall share of agriculture to GDP has declined over the years, a remarkable change has occurred in respect of relative shares of agricultural sub-sectors to GDP. The annual growth rate of crop sub-sector decreased from 6.2% in 2000/01 to 4.22% in

2009/10. Its growth potential has become limited and further growth in this sub-sector will require introduction of new varieties of seeds and a major improvement in the overall agricultural technology- including changes in the quality of seeds. On the other side, the growth rates for livestock, fisheries and forestry sub-sectors increased from 2.8%, -4.5% and 4.9% in 2000/01 to 3.98%, 4.50% and 5.89% respectively in 2009/10 (Appendix Table 1 & 2). Thus the non-crop agriculture exhibited a relatively higher rate of growth during the recent years. This can be viewed upon as an aggregate indicator of agricultural diversification which may be induced by changing policies regarding agriculture.

Agricultural diversification towards products with higher value-added contributed to more rapid agricultural income growth and might contribute to local employment creation by stimulating small farmers' participation in the market. Diversification in production is also likely to lead to diversification in consumption, which is required for healthier and more balanced diets. Therefore, the government is giving emphasis on promoting agricultural diversification involving high-value crops, fruits, vegetables, livestock and fisheries through appropriate packages of seed-fertilizer-irrigation along with other improved technologies. Different studies confirm that agricultural diversification has positive impacts on employment, rural income, promoting exports and improve nutritional standards (Barghouti, et al., 2004; Joshi, 2005; Joshi, et al. 2003; Rahman and Talukder, 2001; Sonam, 2005; Abro *et al.*, 2010).

Many non-cereal crops including pulses and oilseeds are more profitable than modern rice and wheat cultivation due to their low requirement of inputs and less risk involvement. The emphasis on cereal production over the past decades and low output prices and profitability has led to an erosion of crop diversity and dampened agricultural growth in Bangladesh (Mahmud et al., 1994). Therefore, development of improved varieties and better farming practices for non-cereal crops under non-irrigated or semi-irrigated condition will be more profitable and could lead to crop diversification as a successful strategy for the future growth and sustainability of Bangladeshi agriculture (MoA, 1989; Mahmud et al., 1994).

Diversification of agriculture is related to diversification of food consumption. Alam (2005) examined the consumption pattern of Bangladeshi people using Household Income and Expenditure survey (HIES) data through the nineties. It appeared that considerable diversification was taken place in human consumption during the last two decades. The share of rice and wheat in total food basket declined both in rural and urban areas, while the share of potato and pulses increased. This might be lead to further diversification of crop agriculture in future if there are enough incentives to cultivate non-cereal crops.

The rapid growth in domestic demand for fruits, vegetables, dairy products, fats and oils is also creating new opportunities for diversification of agricultural production beyond cereals. Cereal expenditure as a percentage of total expenditure declined from 28.87% to 28.41% in urban areas and from 41.23% to 39.62% in rural areas between 2000 and 2010. In contrast, during the same period expenditure for fruits rose from 4.10% to 5.29% and from 2.59% to 3.49% in urban and rural areas, respectively. Similarly, the consumption expenditures for fish, meat & eggs and spices rose between 2000 and 2010 at national level from 12.48% to 13.71%; 8.02% to 10.31% and 7.13% to 9.99% respectively (HIES, 2010).

Between 1998-1999 and 2007-2008, the value of rice, fruits, vegetables and inland fish output in Bangladesh rose by 2.3%, 10.5%, 7%, and 4.5% per year, respectively. On the other hand, the value of pulses production fell by 1.6% and oilseeds production value increased only slightly by 1.7% per year during the same period, which resulted in large imports of pulses and oils to meet growing demand. By way of comparison, India witnessed a 2.3% rise in value of

both rice and fish output during 1996-1997 to 2001-2002, while the value of pulses and oilseed production plummeted by 2.6% and 3.9%, respectively (Chand, 2003).

Much emphasis was given in the Sixth Five Year Plan (2011-2015) to attain self-sufficiency in food grain production along with increased production of other nutritional crops, as well as to encourage the export of vegetables and fruits keeping in view domestic production and need (SFYP, 2011). Such an emphasis at the policy level enhanced agricultural diversification in Bangladesh. Furthermore, national policy documents (CIP, 2011, NAP, 2010; NFPPA, 2008) recognize the need for diversifying agricultural production. Although it is generally understood that factors such as climate and market risks, agro-ecological characteristics, tenure rights and access to inputs influence the ability to diversify, sufficiently specific evidence for informing policy interventions is not available.

Through an analysis of various data sources (e.g. HIES, agricultural census, FAOStat) and the collection of primary data, the proposed study identified specific factors that constrain and support different types of agricultural households across the country in diversifying their agricultural production. On the basis of these analyses concrete policy options for facilitating agricultural diversification were provided.

1.3 Objectives of the Study

- d. To assist policy makers in identifying policy interventions that will allow agricultural households to diversify their agricultural production into micro-nutrient rich foods and/or those with a strong income generating potential.
- e. To examine past trends of diversification of crop and non-crop agriculture, and compare the rates of growth to those in neighbouring countries to gain some perspective on how rapid (or slow) growth in Bangladesh has been.
- f. To examine socioeconomic and agro-climatic determinants of and constraints to agricultural diversification.

1.4 Key Research Questions

- a. What are the past trends of acreage and production of major food commodities and to what extent they differ from the trends of neighbouring countries like India and Pakistan?
- b. What are the changes in the consumption of different food commodities and how they are related to domestic food production?
- c. What changes have been taken place in financial and economic profitability of different food commodities over time and how they affect their production?
- d. What are the constraints to and opportunities for agricultural diversification in Bangladesh?
- e. What are the determinants of agricultural diversification in Bangladesh?

1.5 Structure of the Report

The report contains a total of 10 chapters, which have been organised in the following sequences. Chapter I introduces the importance of identifying policy options for supporting agricultural diversification in Bangladesh. Purpose of the study and research questions are also outlined in Chapter I. The review of literature relating to the past crop diversification program initiated in Bangladesh, India, Pakistan, and other South Asian countries is discussed in Chapter II in accordance with the study objectives. Chapter III describes the methodological

issues regarding sampling procedure of collecting primary data, analytical procedures of estimating diversifications in consumption, agricultural production, and agricultural trade. The financial and economic profitability and comparative advantages of major commodities over the years have been discussed in Chapter IV. Trend and growth performance of different crops in Bangladesh and international comparative growth performance of major food commodities have been presented in Chapter V and VI respectively. Diversification in consumption, diversification in agricultural production, and diversification in agricultural trade are discussed in chapter VII, VIII and IX respectively. In Chapter X, the constraints to and opportunities for agricultural diversification in Bangladesh have been discussed. Finally, Chapter XI presents the conclusion and policy recommendations for speed up the current agricultural diversification in Bangladesh.

REVIEW OF LITERATURE

The purpose of this section is to review various relevant issues closely related to the implementation of agricultural diversification options. The study reviewed Ministry of Agriculture (MoA)'s crop diversification programs, Five Year Plans, scholarly articles, books and other sources (e.g. dissertations, conference proceedings, etc.). It also reviewed the status and impact of agricultural diversification occurred in India, Pakistan and many other south Asian countries.

2.1 Crop Diversification Programme in Bangladesh

2.1.1 Background

In attaining self-sufficiency in food production, the government of Bangladesh emphasized cereal crops production with the introduction of High Yielding Varieties (HYVs) of rice and wheat since the 70s through a green revolution strategy. Green revolution program resulted in an increase of yield for these crops but at the same time also led to sharp increases in fertilizer, pesticide and water use; increased emission of nitrates and pesticides into the environment; and the depletion of groundwater aquifers. Furthermore, it decreased both area and production of different minor crops like pulses, oilseeds, vegetables, fruits and spices and so import of these products began to rise to meet the increasing demand. This has increased pressure on foreign exchange. On the other hand, fertilizer import also increased to feed farmer's demand to produce cereal crops.

Minor cereal crops are cheaper sources of protein and calorie and they also have a positive impact on the nutrient balance of the soil in one hand, most farmers can easily cultivate those crops after harvesting the major ones on the other. Realizing the importance of growing minor crops, the government launched a Crop Diversification Programme (CDP) in the 1989 which was undertaken jointly by the Government of Bangladesh, the Government of the Netherlands and the Canadian International Development Agency (CIDA). The implementing agencies were the Department of Agricultural Extension (DAE), the Department of Agricultural Marketing (DAM), and the Bangladesh Agricultural Research Institute (BARI). The crops included in the programme were tubers (i.e. potato, sweet potato, aroid); oilseeds (i.e. rapeseed & mustard, groundnut, sesame, sunflower, soybean); and pulses (i.e. lentil, blackgram, mungbean, chickpea, fieldpea, cowpea, and pigeon pea).

2.1.2 Crop diversification patterns

Different crop diversification patterns were recommended and practiced throughout the country. The major cropping patterns based on land types are listed in Table 2.1. *Boro*, *Aus* and *Aman* are all transplanted rice varieties.

Among different cropping patterns, five patterns listed below were reported to be highly adopted patterns in the country (Table 2.2). Different forces influenced farmers to adopt these crop diversification patterns.

Table 2.1 Land type by altitude and associated cropping patterns

Land type	Cropping pattern	Land type	Cropping pattern
High	1. <i>Boro</i> - <i>T.Aman</i> – Fallow	Low	1. Potato - <i>Boro</i> <i>B.Aman</i>
	2. Potato - <i>Boro</i> (HYV) - <i>T.Aman</i>		2. <i>Boro</i> - <i>T.Aman</i> - Fallow
	3. Pulses - Jute – Fallow		3. Kaon - <i>T.Aman</i> - Fallow
	4. Wheat - Kaon - <i>T.Aman</i>		4. Wheat - <i>Boro</i> - <i>T.Aman</i>
	5. Tomato - <i>Aus</i> - Vegetables		5. Jute - <i>T.Aman</i> - Fallow
Medium	1. Potato - <i>Boro</i> - <i>T.Aman</i>		
	2. Wheat - <i>T.Aman</i> - Pulses		
	3. Oilseed - <i>Boro</i> - <i>T.Aman</i>		
	4. <i>Boro</i> - <i>T.Aman</i> - Mustard		
	5. Tomato - <i>Aus</i> - Vegetable		

Source: FAO (2001)

Table 2.2 Highly adopted cropping patterns and reasons for higher adoption

Major patterns	Forces	Major patterns	Forces
1. Potato-HYV <i>Boro</i> - <i>T.Aman</i>	a. Irrigation facility	4. Wheat- <i>Aus</i> - <i>T.Aman</i>	a. Irrigation facilities
	b. Maximum return		b. Credit facility
	c. Land suitability		c. Land suitability
2. Wheat-Kaon- <i>T.Aman</i>	a. Irrigation facility	5. <i>Boro</i> - <i>T.Aman</i> -Fallow	a. Land suitability
	b. Credit facility		b. Demand of cereal foods
3. Pulses- <i>Aus</i> -Vegetables	a. Improving soil fertility		c. Improving soil fertility
	b. Balanced diet		
	c. Maximum profit		

Source: FAO (2001)

2.1.3 Public policies and strategies for crop diversification

Sixth five year plan (SFYP): The GoB has given emphasis on agricultural diversification in various policy documents (CIP, 2011; NAP, 2010; NFPPA, 2008). It is stated in the SFYP (2011-15) that a receptive market, right policy environment, and comparative advantage in certain high-value crops, including traditional fruits and vegetables are existed in Bangladesh. However, the future of non-rice crops will depend on the removal of a number of constraints that currently inhibit their expansion, including comparatively less attention given to development of appropriate technology for non-rice crops and inadequacies of market infrastructure and services (SFYP, 2011).

Major Targets and Objectives of the plan

- To attain self-sufficiency in food grain production along with increased production of other nutritional crops;
- To increase productivity and real income of farming families in rural areas on a sustainable basis;
- To encourage export of agricultural commodities, particularly vegetables and fruits keeping in view domestic production and need;
- To promote adoption of modern agricultural practices in drought, submergence and saline prone areas;

- To encourage research on adaptation to climate change, proper use of genetically modified technology in agriculture.
- To gradually shift the main HYV, irrigation-fed *Boro* rice production to the Southern areas and to utilize new salinity, submergence, and other stress tolerant varieties and also to utilize abundant surface water for irrigation;
- To utilize the irrigated north-eastern uplands to grow more high value cash crops like wheat, maize, corn etc. and horticulture products;
- To increase production of jute, measures have to be taken to improve jute variety and retting system to obtain quality fibers;
- To include oil crops and spices for increased production;
- To encourage research and extension for the promotion of pulse crop;
- To bring coastal and hilly areas under intensive cultivation;
- To encourage comparatively large farm to graduate into commercial farming;
- To promote the use of modern technologies with the help of Information and Communication Technology (ICT);
- To form cooperatives and to construct special growth center only for the actual growers to ensure fair price;
- To strengthen agricultural mechanization for enhancing production;
- To ensure quality seed at farmer's level through the development of community based seed production, storage, and dissemination system;

Policies and Strategies: For achieving the above targets, following major strategies and policies have been adopted in the plan:

- Diversification in food production must address the challenge of achieving balanced nutrition. To achieve this objective, system-based rather than crop based planning for crop sector development will be adopted.
- For crop intensification, the coastal zone, the Sylhet region and the char areas must receive priority in crop sector development plans.
- The short winter season should be kept for the production of non-rice crops. The remaining period could be used for growing two/three rice crops, special emphasis on *Aus* paddy for meeting our rice needs.
- Appropriate land reforms such as (i) ceiling of rents for the fixed rent system, (ii) distribution of *Khas* land among landless and non-viable marginal farmers where ever feasible, (iii) imposition of restriction on conversion of prime agricultural land for non-agricultural uses, (iv) hourly rental system for irrigation equipment instead of crop-share based or season-based fixed irrigation charge, and (v) computerization of records of landownership and land transfer, etc must be attempted.
- Weather forecasts could be made available on a regular basis through mass media, agricultural information and communication center, and cell phone systems.
- For ensuring fair price for both the growers and final consumers through a competitive market environment, it is necessary to reduce the number of middlemen from the marketing chain. In this context, formation of cooperative for the growers and construction of special growth center only for the actual growers could be a way out of this problem.

- For meeting the growing demand of additional food for the increasing people of the country emphasis should be given in utilizing the unutilized hoar land of the north-east part of Bangladesh.
- Strategy, policy and action should be formulated to convert the single crop land into double crop land, double crop land to triple crop land.
- Policies in favor of continuation of subsidization to agricultural inputs e.g. electricity, diesel, fertilizer etc should be emphasized.
- The plan emphasizes on the importance of farm mechanization.
- Policies to construct new food storage facilities to handle 2.8 to 3.3 million tons of food grains annually will be emphasized.
- The plan considers the importance of land reclamation in coastal areas and reclamation of cultivable land in water logging areas and emphasizes on the intensive cultivation of saline tolerant varieties particularly in *Rabi* season and will take necessary steps in this context.
- It is important to ensure increased use of quality seeds for all crops and stop trading of adulterated inputs.
- Measures to encourage surface irrigation e.g. dredging of rivers, canals, sluice gate etc. will be taken.
- To maintain soil fertility use of organic fertilizer will be popularized.
- To meet the demand for additional food for the increasing people, emphasis will be given to utilize the unutilized *Haor* land of the North-Eastern part of Bangladesh.

Country Investment Plan (CIP): In the CIP (2011), the government of Bangladesh has given priority to diversify its agriculture through a number of programs. It has also focused priority intervention areas to enhance sustainable food production through integrated research and extension.

Proposed focus and priority interventions in the plan

Crop sub-sector: The outputs of the program to be implemented in crop sub-sector are productivity enhancement, diversification in food production, and resilience to climate change will be increased through effective generation and propagation of sustainable technological innovation/solution. The proposed focus and priority interventions are:

- a. Enhance research & knowledge generation and adoption to increase agricultural productivity and diversity in a sustainable manner.
- b. Improve extension services to propagate knowledge & practices, supported by community based experimentation & learning and indigenous knowledge.
- c. Promote the development of responses to adapt agricultural systems to climate change.

Fishery sector: The outputs of the program to be implemented in fishery sub-sector are sustainable increase of fishery production through improved technology and natural resources management. The proposed focus and priority interventions are:

- a. Develop small-scale aquaculture, through access to quality inputs, advice and skills.
- b. Improve management of fisheries resources.

- c. Develop public private partnerships in support of infrastructure and services development.
- d. Promote production in the South through sustainable shrimp and prawn development and community-based co-management of wetlands.

Livestock sector: The outputs of the program to be implemented in livestock sub-sector are sustainable increase of livestock production through improved technology, better animal health, and resilient management practices. The proposed focus and priority interventions are:

- a. Strengthen animal health services, including better diagnosis and surveillance systems to mitigate disease outbreaks.
- b. Strengthen husbandry capacity at household level through community based improved knowledge and advisory services.
- c. Improve availability and quality of inputs through public private partnerships.
- d. Research on livestock development, including genetic improvement.

2.1.4 Impact of crop diversification programme

Crop Diversification Program (CDP) which began in the 1980s and continued until the end of the decade was one of the major steps to diversify our crop agriculture. The program was one of the few attempts of the government to shift agriculture from subsistence farming to commercial farming. Alam (2005) found that 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 *Upazilas* than their national average yield. Nevertheless, the growth in total production of these crops remained insignificant due to limited extension support for these crops. However there has been a decline in acreage in these crops. The calculated Simpson Diversity Index (SDI) showed an upward trend over time, from 0.37 in 1972-73 to 0.42 in 1989-90, and 0.43 in 2001-02.

Rahman (2008) examined the impact of CDP on minor crop production and reported that the productions of potato, oilseeds, pulses, fruits and vegetables has increased in the CDP areas compared to the non-CDP areas. He also showed that the level of crop diversity actually increased by 4.5% over the two Agricultural Censuses of 1960 and 1996 period (36 year). He used the Herfindahl index of crop diversification which was 0.59 in 1960 and 0.54 in 1996. After examining the detailed merit of CD, Rahman (2008) argued that development of the rural infrastructure is essential as this will not only improve technical efficiency but may also produce the necessary synergy to promote CD by opening up opportunities for technology diffusion, marketing, storage, and resource supplies.

Agricultural diversification is also adopted for reducing farm household's risk in employment and income. Rayhan *et al.*, (2010) conducted a study on flood affected households and estimated 58% of the rural households to be poor and 67% to be vulnerable in Bangladesh. The monsoon flood causes more damage to cash crops whereas flash flood is riskier for staple crops. He observed that in areas where farm households are vulnerable due to disasters or sudden outbreak of diseases, agricultural diversification at the farm level reduces their vulnerability.

Rahman *et al.* (2001) observed that the numbers of crop, non-crop and non-agricultural enterprises practiced by different farm size groups were the lowest for landless farmers.

Therefore, introduction of agricultural diversification is a very good strategy of this group as it increases opportunities for farm jobs. He also observed that poor farm households are less interested to diversify their agricultural production (out of rice) since their first objective is to secure a minimum availability of food staples for their household. Considering this, it is clear that while agricultural diversification is a very important policy tool for improving the rural economy, the policy needs to be examined carefully in order to promote this among the most vulnerable people.

2.1.5 Constraints to the promotion of CDP crops

Each CDP crops experienced a different set of problems. However, the Ministry of Agriculture (2000) identified some common constraints for promoting crop diversification in Bangladesh. These constraints are:

Non-availability of suitable land: Most farmers used their suitable lands for HYV *Boro* cultivation for food security reasons and the potential of expanding area under CDP crops was limited. Therefore, the CDP crops were mostly confined to marginal and relatively less fertile lands resulting low yield and production.

Non-availability of water and technologies: Most of the CDP crops, except pulses, require irrigation during the dry season. But the subsistence farmers could hardly afford to irrigate crops other than rice. Besides, the non-availability of suitable technological package and water management system for the production of crops other than rice was considered to be major agronomic constraint to diversification of crops and cropping systems.

Low adoption rate of new varieties: Although a good number of improved varieties for different CDP crops and maize were available, diffusion of these varieties and other technologies had not yet been widely spread. Non-availability of seeds, inadequate extension service, absence of adequate post-harvest technology, lack of improved marketing, storage and processing facilities, etc. were considered to be the major constraints to the wider adoption of these varieties.

Imports as disincentives to diversification: A huge amount of pulses, oilseeds and edible oils were imported every year. Import exposes local production to compete with world market producers. In that time, the harvest prices of lentils and mustard were higher than the world market price and the world market prices for oilseeds were declining in that period. The international competitiveness of these crops reduced their prices when miller costs and profits of the wholesalers were added in the harvest prices.

Existing marketing system as detrimental to diversification: The prices of most CDP crops generally drop to the lowest levels during the time of harvest. Farmers are compelled to sell at least 40-50% of their output at any price prevailing at harvest for cash need. This reduces their incentive to diversify their system with these crops. Moreover, primitive market infrastructure substantially increases the cost.

Other studies also noted constraints like low yield rates, lack of price incentives, lack of credit, poor knowledge on nutritional value of the crops and limited industrial uses hinder the growth in production of Coarse Grains, Pulses, Roots and Tubers (CGPRT) crops in Bangladesh (Alam, 2005).

2.2 Agricultural Diversification in India

India is one of the populated countries in the world. It also launched agricultural diversification (AD) programme since 1980 to meet the growing demand for food and nutrition, and to face the global challenges of international market. An attempt has been made in this section to

present an up-to-date status of AD in India through reviewing different scholarly research articles.

2.2.1 Nature of diversification

In India, crop diversification process was started from the West Bengal state since 1970's. Diversification towards High Value Crops (HVC's) in this state was directly come through the efforts of small farmer by the tiny support of the government. This process was found adverse in the rain fed areas compared to the irrigated areas for less irrigation cost which was much higher for cereal crops (Bhattacharyya, 2008). It was observed that crop diversification was increased at slow rate, but land reallocation for some crops has been taking place continuously. The advanced districts could maintain their level of diversification satisfactorily due to the availability of agricultural and supporting infrastructure, whereas diversification was gradually increased in the laggard districts due to increase in irrigation and other facilities (De, 2010).

In Himachal state, technology-led agricultural diversification programme was started in 1980, whereas price-led diversification programme was launched in 1990 (Mehta, 2009). Different studies (Bhattacharyya, 2008; Rao, 2004; Raju, 2005) showed that a significant diversification occurred in all of the sub-sectors of agriculture through diversifying cereal and low value crops to HVCs like fruits, vegetables, milk, meat and fish. A good percentage of non-food crops have also grown in India under crop diversification initiatives (Jha et al. 2009). Based on the speed of diversification towards HVC's, Rao (2004) categorized it into three zones as high, medium and low, and showed that HVC's contributed 60% share to the crop sector in high diversified zone whereas this percentage was 20% for low diversified zone.

Gradual diversification of Indian agriculture towards high-value crops exhibits a pro-smallholder bias, with smallholders playing a proportionally larger role in cultivating vegetables versus fruits. Small or medium holders do not appear to allocate a greater share of land to fruits or vegetables. However, the share of land allocated to vegetables is significantly higher for large farmers and the reverse is true for producing fruits (Birthal *et al.* 2007). Diversification toward crop-mix of non-food crops also occurred across the region. The area under pulses and oilseed has increased by reducing the area for millets and coarse cereals. Farmers shifted from groundnut cultivation towards sunflower and soybean cultivation (Raju, 2005).

A significant structural change has been occurred in the livestock and fisheries sub-sector involving large number of small farmers. The overall share of agriculture in the GDP has been decreased and the shares of livestock and fisheries in agriculture have been increased (Raju, 2005). Satyasai (1997) found that agricultural diversification toward non-crops is also significant in India. He showed that the contribution of crop and livestock sub-sector to the total agriculture income increased from 87.86% in 1950-51 to 92.90% in 1990-91. During this period, the contribution of crop sector has been decreased in one hand and the contribution of livestock sector has been increased on the other. The contribution of fisheries has been doubled from 1.23% to 2.37% in the same period. Diversification toward producing milk, egg, and meat are also observed to be the fastest growing sub-group of HVC's in India (Rao, 2004).

2.2.2 Regional agricultural diversification

There has been a significant change observed in the pattern of agricultural diversification at the regional level in India for the period of 1983, 2003 and 2006-07. Some pocket areas have been emerged in some sub-regions due to specialization in cultivating several non-cereal crops or group of crops (Jha et al. 2009). The southern region achieved maximum diversification

compared to the western region (Joshi et al., 2007). Among the Indian states, Kerala and Andhra Pradesh shifted significantly from food grain to non-food grain crops between 1970-71 and 1990-91. Haryana, Kerala, Rajasthan and Orissa changed their non-food grains area in the highest percentage. Crop diversification significantly increased the producing area for groundnut in Andhra Pradesh, Karnataka, and Tamilnadu; coconut and rubber in Kerala; soybean and sunflower in Maharashtra; rapeseed/mustard in Gujarat; cotton in Rajasthan, Punjab and Haryana; and sugarcane in Uttar Pradesh (Raju, 2005). Ralph *et al.* (2007) found that the farmers of two food-surplus states, Punjab and Andhra Pradesh are responding to the changing scenario and gradually diversifying production towards high-value commodities. In Punjab, the rice-wheat system still dominates, with only dairying rescuing the agriculture sector. Andhra Pradesh has diversified much more towards dairy, poultry, fisheries, fruits and vegetables, by replacing coarse cereals and rice.

2.2.3 Determinants of agricultural diversification

In India, several factors are identified as the determinants of agricultural diversification. Singh et al. (1985) found a negative relationship between agricultural diversification and farm size. Anosike et al. (1990) found that land tenure, off-farm activities, education and environmental variation significantly influenced crop diversification. Joshi (2006) showed that technology was the main source of income growth and crop diversification towards HVC's which generates 27% of crop income growth in 1980's and 31% in the 1990's. They gave more emphasis on institutional development to make strong linkage between small farmer and market which can enhance more diversification. Joshi *et al.*, (2003) found that agriculture diversification is strongly influenced by price policy, infrastructure development, urbanization and technological improvements. Ralph *et al.*, (2007) stated important factors that have contributed to promoting agricultural diversification include urbanization and per capita income on demand side and watershed programs on supply side. Growing agro-processing has impacted production of fruits. According to Joshi et al. (2007) diversification has strong positive relationship with urbanization. Bhattacharyya (2008) showed that change in the demand side factors was one of the major determinants of diversification which induced the farmer to produce for HVC's. Jha (2009) identified several drivers of agricultural diversification in India. The driving forces were increase road density, agricultural commercialization due to urbanization, and farm specialization in region based on some crops.

In Haryana state, crops become diversified towards HVC's in Sonapat, Rohtak and Gurgaon district due to the proximity of metropolitan city (Delhi), sprinkler irrigation system was found to be the main determinants of crop diversification in Bhiwani district (Malik, 2002). Rao (2004) identified different factors such as lack of access to technology, adequate infrastructure and policy support that were responsible for low diversification. De (2005) revealed that irrigation expansion and technology adoption were the main contributors of fast area expansion for crop diversification in West Bengal. De (2010) also pointed out that increased facility of electricity supported irrigation, storage and marketing facility has largely contributed to crop diversification in West Bengal. He recommended that fertilizer availability, irrigation expansion, increase in crop yield, agricultural infrastructure, and road network are the preconditions of diversification.

2.3 Agricultural Diversification in Pakistan

The clear picture about the agricultural diversification of Pakistan has not been focused in this section due to scarce literature. However, an attempt has been made to show some glimpse of the agriculture diversification of Pakistan.

Agricultural diversification in Pakistan was initiated from the green revolution period at late sixties and early seventies (Abro, 2010). The diversification process was reported to be slow during the last two decades. The country is diversifying some commercial high value crops like vegetables and fruits. Diversification towards high value crops was achieved in the 1980's through the expansion of area under sugarcane, orchards, vegetables and non-traditional oilseed crops (USAID, 2009). A statistics show that 76.37% crop lands are covered by wheat, rice, sugarcane, maize, gram and cotton and the rest 23.63% are covered by other minor crops (Accountancy, 2008). This indicates that there are still great opportunities to diversify the agriculture of Pakistan towards high value crops.

The impact of diversification can be evaluated through assessing the sectoral contribution of agriculture. Like other South Asian countries, sector contribution of agriculture to the gross domestic product (GDP) is decreasing gradually in Pakistan. It is observed that contribution of crop sub-sector in the agriculture sector was declined in the period from 1990-91 to 2006-2007. Again, the contribution of livestock has increased and the contribution of fisheries and minor crop remained insignificant in this period. According to Accountancy (2008) there is no policy support to diversify the agriculture in Pakistan before two years ago of 2006-07. In the last few years, government took initiative to expand only four major crops (wheat, cotton, sugarcane, and rice) which accounts for 33% of the agricultural value addition. For this reason, the rest of the crops and livestock sector remain significantly neglected by the government before two years of 2006-07. As government neglected the non-food crop and non-crop sub-sector so the agricultural contribution to GDP has decreased.

Kuroshaki (2004) compared the agricultural growth between of Pakistan and India. He found that the farmers of Pakistan and India contributed in the agricultural growth through adjusting their crop mix and production technology, which was supported by the institutional and policy change of the two countries. The author identified that the crop concentration indices were the highest level in the 1990's in both the country.

Diversification leads to economic development of the farm and farmer. Some households in Pakistan could escape from the poverty through crop diversification, investing in education and non-farm employment (Lohano, 2009). Abro (2010) showed that as per hectare income from minor crop is higher than the income from the major crop, so diversifying to the minor crop can help to alleviate the poverty of the poor farmer. Agricultural diversification in Pakistan was influenced by several determinants. Ashfaq *et al.*, (2008) identified that the major diversification determinants in Pakistan were the land holding size, age of respondents, education level of the respondents, farming experience, off farm income, distance of farm from main road, distance of farm from main market, and farm machinery.

2.4 Agricultural Diversification in Other South Asian Countries

Agricultural diversification has been used around the world as a strategy to increase income of the farming household and at the same time to reduce risks. In most cases, it often been seen as a move towards production of high value products. This means higher income, more employment in rural economy and so it stimulated the farm economy. That's why many South Asian countries are gradually diversifying their agriculture in favour of high value commodities, namely fruits, vegetables, livestock and fisheries. Experiences show that agricultural diversification has augmented income, generated employment opportunities, empowered women farmers, and conserved natural resources (Joshi, 2005; Sonam, 2005; Abro *et al.*, 2010). It also contributes to increase exports of high value commodities (Joshi *et al.*, 2003) and for countries primarily selling agricultural produces this is a very successful strategy for accelerated growth.

The overall diversification of South Asian countries was studied by Dorjee et al. (2003) and Joshi et al. (2003). Dorjee et al. (2003) identified that over the last two decades the cereals production has been growing at about 2% per year and the growth rate of livestock, fruits and vegetables was 4.5%. This is also justified when it is observed that vegetables production as percentage of cereals production increased from 10% in 1980 to 15% in 1993. In a consequence of that, the share of cereals in agricultural output is unchanged but its consumption is declined in the South Asia. This indicated that HVC based agricultural diversification has played an important role in consumption diversification in South Asia. This is also supported by another study of Joshi et al. (2003), where they stated that South Asian countries are diversifying gradually towards HVC. This diversification is significantly influenced by price policy, infrastructure development, (like markets and roads), urbanization and technological improvements. Farmers are highly benefited through substituting the inferior coarse cereals with HVCs in rainfed areas. They suggested that diversification should be strengthening through market reform and efficient institution in the South Asian region to increase small holders' household income and promote export. Through the growth of diversification is observable but still there are more scope for diversification.

In Nepal, agricultural diversification through the policy implementation was started in 1997. At that time Nepal government initiated Agriculture Perspective Plan (APP) for 20 years agricultural development and growth of 5% through diversifying agriculture to transform the farming system from substance to commercialized farming (APROSC and JMA 1995). In spite of this initiative, Nepal agriculture did not achieve a successful stage to reduce poverty and deprivation. Bhutan has achieved a significant diversification from the last two decades compared to Nepal.

Tobgay (2005) pointed out that agricultural diversification in Bhutan is a recent trend which was initiated from 1980's. Until 1970's vegetable production was limited to kitchen gardening. After 1980's the country started to diversify the vegetable production through introducing 30 types of vegetable and contributed in cash income and nutrition to the rural poor. Bhutan is also producing summer vegetables and exporting to India. Bhutan started to produce potato through initiating three high yielding potato varieties in the early 1980's. Now the country is exporting potato with an increasing growth rate. The author identified that the increase diversification was mainly due to road construction which improves access to market of farm produce.

Some South East countries also undertaken long-term and short-term policy and project for agricultural diversification. Siregar and Suryadi (2006) stated that in Indonesia, food crop diversification was included in the Fifth Five Year Plan (Pelita V) as an instrument of food and food nutrition security, income growth, poverty alleviation, employment generation, cautious use of natural resources, and sustainable development. But in spite of the plan there was no clear guideline for the implementation of the plan which is identified by Karama et al. (1992). The author also mentioned that as most of the policy like production, marketing, price support, food and international trade of food crops were rice biased. Therefore, decline of the food crop diversification is observed in Indonesia. This is observed in Indonesia through the statistics that, though 71% of the agricultural households grew food crop but only 39% of them grew CGPRT crops. These CGPRT crops were grown in the less favourable land than irrigated land. The author expressed that if the government was prioritized the CGPRT crop development, then poverty would have been lower and crop diversification would have improved.

Siregar and Suryadi (2006) studied the diversification of agricultural through sustainable development of the CGPRT crops namely maize, soybean, groundnut, cassava, potato and

sweet potato in Indonesia. They stated the need of alternative crops and favourable trade policy for rice to receive successful diversification. More tariffs should be imposed to reduce the dependency on imported wheat and CGPRT crops (i.e. maize and soybean) so that farmer will be encouraged to produce these crops. It is also important to encourage partnerships between farmers' organizations and processing companies/export to secure the better price for farmer. The other steps need to be taken for successful agricultural diversification were strengthening research for CGPRT crops, improving marketing efficiency, and increasing institutional support for both farmer and market.

Ahmad and Isvilanonda (2003) stated that Thailand agriculture has moved to diversification during 1980's and 1990's. This led to increase the share of agriculture in national export earnings. But higher regional specialization and inability to diversify to profitable crops led to inadequacy of farm level diversification which helps to increase the rural poverty and regional inequality in Thailand.

Goletti and Rich (1998) identified the alternative policy options for agricultural diversification in Vietnam. The author identified diversification options for sugarcane, livestock feed and coffee sub-sector. It is concluded that livestock diversification is important for the poor and proper exploitation of the HVCs. The prerequisite to livestock sector development is the improvement of the meat processing and health standards. Livestock feed sector can be improved through increase rice sector. The agriculture diversification can be more effective through identifying regional comparative advantage.

Boris *et al.* (2006) argued that more diversified farm plans are positively associated with farm size, schooling, participation in communal organizations, and with the frequency of extension visits. A significantly lower degree of diversification and a stronger reduction in diversification over time is also reported for businesses operated by older, less educated, part-time farm operators (Weiss and Briglauer, 2002).

Dorjee *et al.* (2003) identified that the major constraints of diversification opportunity in the South Asian countries were the size of the market, price risk, soil suitability, land rights, availability and quality of irrigation infrastructure, availability of labour, and cost of labour. The main constraints of agricultural diversification perceived by subsistence farmers in Thailand are lack of access to production factors, whereas for commercial farmers it is the marketing problem (Ahmad *et al.*, 2003). Ahmad and Isvilanonda (2003) identified that the major constraints to diversification were lack of access to production factors and marketing problems. Sonam (2005) stated lack of adequate infrastructure, limited access to information, credit, and other assets can severely constrain the scope of diversification initiatives in Bhutan. At the same time, since high value crops are labour-intensive, higher wages could also be a constraint in their production (Ralph *et al.*, 2007).

2.5 Concluding Remarks

In its efforts to attain self-sufficiency in food production to feed a growing population since 1972, the government of Bangladesh has promoted cereal crop production with the introduction of HYV of rice and wheat and by launching Green Revolution and Grow More Food programmes. As a result of these initiatives, cereal crop production has increased tremendously, but land allocation and yields for minor crops, such as pulses, oilseeds, vegetables, fruits and spices, has decreased. Despite the policy emphasis on cereals, demand for minor crops increase and the government expended valuable foreign exchange to import them. Realizing the importance of growing minor crops, the government launched the CDP in 1989. Although diversification remained low, some studies show positive impacts of the CDP

on production of tubers, oilseeds and pulses. The level of crop diversity increased by 4.5% over the 36-year period from 1960 to 1996, when the two agricultural censuses were conducted. The common constraints for promoting crop diversification are non-availability of suitable land; non-availability of water and technology packages; low adoption rate of new varieties; imports of pulses and edible oils as disincentives to diversification; and lower price of CDP crops.

The literature reviews have pointed out some major bottlenecks in terms of diversifying agriculture out of rice for South Asian countries. This includes, a) market access, b) access to input, c) access to information related to other crops, d) access to credit, and also e) access to 'fair price' due to missing markets or undeveloped market infrastructure. These are important determinants of crop diversification in South Asia.

For any future studies these are the starting point for understanding the factors for promoting agricultural diversity. At the same time, in the last few decades, significant changes took place in agriculture in every country. Growth in transport and communication infrastructure has significantly reduced 'distance' to market. Farmers are now more informed than farmers of the 80s and 90s. As such, it was expected that diversification of agriculture would increase. Unfortunately, however, data (presented in Chapter VIII) suggest that agricultural diversification is not growing as fast as should have been despite significant progress made in infrastructure, extension support, market development, etc. Consequently, this study will dig deeper into these issues to find factors to promote agricultural diversity.

METHODOLOGY OF THE STUDY

3.1 Technique and Data Sources

The study used both secondary and primary data and information. The main categories of information used in this study were: (i) Synthesis of relevant findings from existing literature; (ii) Secondary data and information from available sources; and (iii) Primary data and information obtained from sample survey.

In order to formulate suitable policy guidelines for agricultural diversification, the study reviewed the existing status of financial and economic profitability of agricultural productions, agricultural incentives, and the comparative advantage of cultivating agricultural commodities by using scarce resources. Data and information in this purpose were collected from national research institutes, public universities, research publications of FAO, and journal articles.

The land area under agricultural production has been shrinking over the time. There is ample scope for increasing the physical yields of particular crop and non-crop enterprises through changing cropping patterns and crop varieties. An index approach considering five years average was applied to show the trend of area, production and yield of different food commodities in Bangladesh. The study also analyzed the trend and annual growth of area, production and yield of different crop and non-crop enterprises by regions of Bangladesh using secondary data from 1990 to 2009. Besides, the trends and growth rates of area, production and yield of major food commodities of Bangladesh were compared with the trends and growth rates of those in neighbouring countries like India and Pakistan for gaining some perspectives on how rapid (or slow) growth was occurred in Bangladesh. FAO statistics were used in this purpose.

The consumption pattern in Bangladesh has been changed and diversified over the years due to various reasons. Therefore, the study analyzed the consumption pattern of different food commodities and its changes over the time through analyzing time series and various HIES data. It also analyzed time series data on major food commodity production, export and import to estimate the net consumption.

The pattern and extent of agricultural diversification and inter-linkage effects were examined both at macro and micro levels. The overall agricultural diversification was examined in terms of diversity of both crop and non-crop agricultural activities. Evidences on establishment of commercial dairy, poultry and fish farms according to geographical locations were gathered and analyzed. The determinants of agricultural diversification were examined both at the macro and micro levels using district panel data and primary household data respectively. The constraints and opportunities for agricultural diversification in Bangladesh were also explored. A typical farm generally found in the rural areas was organized in such a way that a number of crop and non-crop enterprises were confined to constitute a farming system. All these aspects were examined in the study by utilizing the micro level data which were collected through farm survey.

Despite the progress made over the last two decades, Bangladesh has to depend on imports for food availability over the years. Bangladesh is a net importer of most food commodities including cereals and non-cereal commodities. The study analyzed the growth performance of

international trade for selected food commodities in Bangladesh and compared those with neighbouring countries India and Pakistan. Data and information regarding this aspect were collected from FAO stat and BBS publications.

3.2 Farm Survey Techniques

3.2.1 Selection of non-cereal crops and non-crop agricultural products

In order to examine the socioeconomic and agro-climatic determinants of and constraints to agricultural diversification at micro level, three sub-sectors namely crop, fisheries and livestock were considered for this study. Eight fast growing crops were selected from an initial list of 21 crops using growth rates in area and in production from past 15 years of data (Appendix Table 3). In addition two non-crop products like poultry and culture fisheries were selected for this study. As a result, selected 10 products for this study were maize, potato, pointed gourd, okra, onion, garlic, banana, pineapple, culture fish, and poultry. Maize is considered as a feed crop and so was included.

3.2.2 Selection of study areas

Multi-stages sampling procedure was followed to select sample study areas for farm survey. In the first stage, two districts with highest production for each selected product were selected for farm survey. The process is to select two districts for each product and so 12 districts were selected for farm survey. In some cases, a district might have more than one selected product for the purpose of the survey. Twelve districts are: Dinajpur, Rangpur, Bogra, Pabna, Jessore, Kustia, Mymensingh, Tangail, Faridpur, Gazipur, Chittagong, and Rangamati.

In the second stage of selecting the sample, information on area and production of 10 selected products were collected from agriculture extension office of all *Upazilas* in the selected district over telephone. Based on the highest production, for each crop two *Upazilas* from each district (or four *Upazilas* in two districts for each product) were selected for the study. However, there were overlaps and so 40 *Upazilas* were finally selected for 10 products.

In the third stage of sampling agricultural blocks were selected. From each of the selected *Upazilas*, one agricultural block was selected in consultation with DAE personnel. The selected blocks were used for gathering primary data and information from the farm households engaged in producing selected products along with other crops.

3.2.3 Sampling of farm household

Multi-stage sampling technique was used in selecting the farm households. As was mentioned, data were collected from 40 'Agricultural Blocks' under selected *Upazilas* of the respective districts of Bangladesh. In each stage, the criterion was the ranking based on volume of production of selected products. Accordingly, a total of 600 farm households taking 15 households from each block who were involved in producing the selected products were selected for interview. Again, the survey covered a total of 360 farm households (i.e. taking 30 households from each district) who were not involved in growing selected products and mostly involved in growing rice and wheat. Thus the total sample size was 960 (Table 3.1).

Table 3.1 Study area, selected products and sample design of the study

Sl. No.	District	Crops	Households	Control group	Total sample
1.	Dinajpur	Garlic, Maize, Pointed gourd, Potato	120	30	150
2.	Rangpur	Maize, Banana	60	30	90
3.	Bogra	Potato	30	30	60
4.	Pabna	Onion	30	30	60
5.	Jessore	Okra, Pointed gourd, Culture fish	90	30	120
6.	Kustia	Banana, Okra	60	30	90
7.	Mymensingh	Culture fish	30	30	60
8.	Tangail	Pineapple	30	30	60
9.	Faridpur	Onion, Garlic	60	30	90
10.	Gazipur	Poultry	30	30	60
11.	Chittagong	Poultry	30	30	60
12.	Rangamati	Pineapple	30	30	60
	Total samples		600	360	960

Note: Selection of crops and selection of districts are explained in sections 3.2.1 and 3.2.2.

3.2.4 Enumerators training and data collection

The data from the study areas were collected through trained enumerators along with co-investigators of the project using a pre-tested interview schedule. The field work was constantly monitored by the principal researchers. Before going to field survey, the enumerators were provided one-day hand-on training that would include class lecture and field visit for minimizing error in data collection. Initially, 10 scientific staffs were considered for training so that we can utilize them properly when necessary. The primary data were collected during May-July, 2012. The collected data were checked and verified for consistency and corrected through consultation with respondent farmers over mobile phone.

3.3 Analysis of Datasets

The collected primary data were processed through appropriate computer package in the pre-designed format. The analysis was done through derivation of a useful set of descriptive statistics. Detailed analytical techniques have been described in the following sections.

3.3.1 Financial and economic returns of enterprises

The economic and financial returns of cereal and non-cereal commodities enterprises were highlighted in this study. For this purpose, various research reports prepared by BARI, BRRI, BINA, BLRI and Agricultural universities were consulted. Besides, relevant articles published in different journals were also taken into consideration.

3.3.2 Trends and patterns in domestic production

In order to gain some perspective on the growth rate of production, yield, and net international trade of selected food commodities in Bangladesh, time series data for 20 years (1990-2009) were collected and used for a trend analysis. Using FAO statistics, similar data from Pakistan and India were used for a comparative analysis of trends and growth in area, production and yield of selected food commodities.

Five year average was used to estimate fluctuation and an index was prepared to compare the change in area, production and yield of different food commodities considering 1990-1994 as base period. The reason of considering five year average is that any development work in

Bangladesh generally requires 5-year time. Therefore, it is easy to show the changes occurred in any variable over time. The formula used for calculating index number was follows:

$$\text{Index} = \frac{\text{Current year value}}{\text{Base year value}} \times 100 \text{-----} [1]$$

3.3.3 Growth and decomposition analysis of agriculture production

In order to gain some perspective on the growth rate of area, production, yield, and net international trade of selected food commodities, time series data for 20 years (1990-2009) were used for a trend analysis.

The compound growth rates of area, production and yield of different food commodities were worked out by fitting a semi-log trend equation (2) of the following form:

$$y = e^{a+bt} \text{ or } \text{Ln}(y) = a + bt \text{-----} [2]$$

Where, Y defines the time series data of production, area and yield of crops; ‘t’ is the trend term (time) and ‘a’ is the constant coefficient. The slope coefficient ‘b’ measures the relative change in Y for a given absolute change in the value of explanatory variable ‘t’. If we multiply the relative change in Y by 100, we will get percentage change or growth rate in Y for an absolute change in variable ‘t’. The slope coefficient ‘b’ also measures the instantaneous rate of growth.

To analyze the sources of changes in different agricultural commodities, Hazell’s Variance Decomposition procedure¹ was used. To measure the relative contribution of area and yield towards the total output change with respect of individual commodity, component analysis model was used. In the literature, several researchers have used this model to study growth performance of the crops (Siju and Kombairaju, 2001; Akter and Jaim, 2002; Kakali and Basu, 2006).

$$\Delta P = \bar{A} \Delta \bar{Y} + \bar{Y} \Delta \bar{A} + \Delta \bar{A} \Delta \bar{Y} + \Delta \text{Cov}(A, Y)$$

$$\frac{\bar{A} \Delta \bar{Y}}{\Delta \bar{P}} \times 100 + \frac{\bar{Y} \Delta \bar{A}}{\Delta \bar{P}} \times 100 + \frac{\Delta \bar{A} \Delta \bar{Y}}{\Delta \bar{P}} \times 100 + \frac{\Delta \text{Cov}(A, Y)}{\Delta \bar{P}} \times 100 = 100 \text{-----} [3]$$

Δ represents change in the variable between two periods, P is production, Y is yield, and A is area.

Thus, the total change in production is attributed due to area and yield that can be decomposed into four effects viz: yield, area, yield & change in area and yield interaction, and covariance effects. Covariance term shows the interaction between variances in areas and variances in yield because cov(A,Y) is defined as **correlation** × √[(**variance(A)** × **variance (Y)**]. This is also known as **residual effect** or effects not explained by either area or yield.

3.3.4 Trends and comparison over time in domestic consumption

HIES data for three latest surveys were analyzed according to household’s residence, poor and non-poor, farm category, and bottom and top quartile group to compare and understand the

¹Variance decomposition procedure (Hazell,1982; Hazell, 1985) allows the quantification of contribution of different sources of change in mean and sources of change in variance of the total production such as change in mean yield, change in mean area, change in yield variance, change in area variance, interaction between mean yield and mean area etc.

trends and level of per capita consumption of selected food commodities. On the other side, the per capita availability of different food items was calculated using the following formula:

$$PCA_i = \frac{Production_i(1-\theta_i)+Import_i-Export_i}{Population} \quad \text{-----} \quad [4]$$

Where, PCA_i is per capita availability of the i^{th} food item, θ_i is the rate of post-harvest loss in food items i . Data related to domestic production, import and export were collected from BBS.

3.3.5 Measurement of consumption diversification

The overall consumption pattern in Bangladesh has been changed over the time due to various socioeconomic reasons. So, it is important to understand the magnitude of changes occurred in the non-cereal food consumption for policy reasons. Diversification in consumption was measured in two ways: i) diversification in cereal consumption, and ii) diversification in calorie (energy) consumption. The following formulas were used for calculating consumption diversification.

$$\text{Share of cereal consumption} = \frac{\text{Total cereal consumption}}{\text{Total food consumption}} \quad \text{-----} \quad [5]$$

$$\text{Share of calorie intake from cereals} = \frac{\text{Total calorie from cereals}}{\text{Total calorie from all foods}} \quad \text{-----} \quad [6]$$

3.3.6 Measurement of agricultural diversification

Since this study is focused on understanding the factors behind agricultural diversification so that informed policy could be developed, measurement of agricultural diversity is an important issue for this research. Traditionally, crop diversification at a given time and space is examined by using several indices (*for details, see end note*). The indices are Herfindahl Index, Ogive Index, Entrophy Index and Simpson Diversity Index. These indices were used in several studies to measure crop diversification in this region (Islam and Rahman, 2012; Rahman, 2008; Bhattacharyya, 2008; Jha, et al., 2009; Malik, 2002). Most of these indices use proportion of land to assess diversity, which is not necessarily valid when poultry, fisheries and dairy or similar production are included in the bundle. Poultry and dairy, for example, can be produced without access to crop land.

This research primarily focuses on understanding agricultural diversity (not crop diversity) which includes homestead farming as well as livestock, poultry and fisheries. Since agriculture in Bangladesh is mostly geared producing cereal crops (rice & wheat), the agricultural diversity in this study refers to promotion of agricultural production into non-cereal crops and other farming practices. As such, the agricultural diversity index used in this study measures diversity of non-cereal production for a farm household. Accordingly the following index was used to capture the overall agricultural diversity.

$$ADI_k = \frac{\sum_j^m y_j}{\sum_i^n y_i + \sum_j^m y_j} = \frac{\text{Value of non-cereal produces}}{\text{Total value of agricultural produces}} \quad \text{-----} \quad [7]$$

Where, ADI_k is agricultural diversity index in the k^{th} district or k^{th} farmer, y_i is the value of cereal crops ($i= 1 \dots n$), and y_j is the value of non-cereal agricultural crops ($j = 1 \dots m$). Non-cereal agricultural crops include non-cereal crops, poultry, livestock and fisheries. The index value varied from 0 to 1. Zero means the farm/region is producing only cereal products and 1

means it is concentrated on non-cereal products. If diversity is considered to be moving away from tradition cereal production, then higher the value of the index would suggest more diversification.

3.3.7 Determinants of agricultural diversification at micro level

The diversity of agricultural production actually depends on the ability of farmers to adapt new agricultural products in their land which in turn depends on: a) their individual skills to adapt including risk taking behavior, b) on some household characteristics like number of family labor available, educational attainment of the household, gender distribution within the household, income and wealth status and so on; and c) local and community characteristics like soil and weather conditions, the behavior of neighboring farmers, etc.

At the micro level, following probit model was used. This was a micro-behavioral study based on field level data for farmers across the country. The dependent variable of this model is the value of agricultural diversification index (ADI). In other words, the dependent variable is the share of non-cereal income to total agricultural income of the farmer. The value of dependent variable is 0 when the farmer is producing **only** cereal (rice and wheat) products otherwise the value is 1. The empirical probit model is as follows-

$$ADI = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + U_n \text{ -----} [8]$$

Where,

- ADI = Farmer's agricultural diversity index (Only cereals = 0; Otherwise = 1)
- α = Intercept
- X_1 = Irrigated land (decimal)
- X_2 = Land suitability dummy (if suitable 1, otherwise 0)
- X_3 = No. of training received
- X_4 = Extension linkage (score value; high score indicates higher linkage)
- X_5 = Family influence in production [scale 0-4, (high influence = 4, no influence = 0)]
- X_6 = Credit facility dummy (if available 1, otherwise 0)
- X_7 = Storage facility (if available 1, otherwise 0)
- X_8 = Access to market (km); Considered lowest distance from home, market & union parished
- β_i = Coefficients of respective variables to be estimated (i = 1, 2,3 -----9)
- U_i = Error term

3.3.8 Determinants of agricultural diversification at national level

The overall agricultural diversity of a geographic region is likely to be influenced by many socio-economic factors. It could be determined using the number of crops and their acreage in a region throughout the year. Based on a composite index of agricultural diversity, it is possible to develop a model where regions (in this case district) with higher diversity vs low diversity can be studied.

Ten years panel data (2001-2010) on different variables were taken from 23 districts (old administrative classification) to develop a regression model to understand the relative importance of the variables on the overall agricultural diversity of the region. Initially it was planned to specify a regression model with 18 variables. Unfortunately, the panel data on all the variables were not available in the secondary sources and many of these available variables were not relevant for specifying the model . However, the following empirical regression model was used to identify the factors influencing agricultural diversification at national level.

$$ADI = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + U_n \text{ ----- [9]}$$

Where,

- ADI = ADI for a district of a particular year (continuous value)
- α = Intercept
- X_1 = Real wage rate in Tk/day {Nominal wage/Boro rice price (Tk/quintal)}
- X_2 = Real wage rate square
- X_3 = Per capita road length in km (road length/population)
- X_4 = Per capita road length square
- X_5 = Rainfall (mm/year)
- X_6 = Agricultural credit disbursement (Lac taka/year)
- X_7 = Population (no.)

3.3.9 Measurement of trade diversification

The percent shares of net import and net export of a commodity to its production and consumption could be used to understand trade exposure of the commodity. This could be done using a net trade index. For a net importer the index value will be negative and for a net exporter it will be positive. Trade diversification is measured in three ways using the following formula.

(i) Share of non-cereal agricultural trade to total merchandise trade =

$$\frac{\text{Net trade of non - cereal product trade}}{\text{Total merchandise trade}} \text{ ----- [10]}$$

(ii) Share of non-cereal commodity trade to total agricultural trade =

$$\frac{\text{Net trade of non - cereal products}}{\text{Total agricultural trade}} \text{ ----- [11]}$$

(iii) Share of non-cereal food trade to total food trade = $\frac{\text{Net trade of non - cereal food}}{\text{Total food trade}} \text{ ----- [12]}$

PROFITABILITY AND COMPARATIVE ADVANTAGE OF MAJOR COMMODITIES PRODUCTION

4.1 Background

The profitability of production crucially depends on prices of products, cost of production and availability of technology. So far, the government of Bangladesh has been using price support policy on rice to regulate price of rice throughout the year. This has implications both for the exchequer and for the farmers. It adds to the amount of subsidy given to both farmers and urban poor who receives rice at a regulated price. It also affects the farmers because it provides a certainty of income (if they produce rice by reducing price variations and it also reduces the overall profitability of the farm when they choose not to adopt other crops). Consequently, agricultural diversity is dependent on the government policies on prices. Similarly, input subsidy also changes the relative profitability of production and hence subsidy on fertilizer, seed, etc. often changes the nature of changes taking place in agriculture.

In order to formulate suitable policy guidelines for agricultural diversification in Bangladesh, the planners and policy-makers need overall information regarding the profitability of growing crops and non-crops enterprises; prevailing agricultural incentives structure; nature of price distortions; trading opportunities; and comparative advantages, without subsidies or with limited subsidies, of growing crops and non-crops enterprises. Therefore, an attempt has been made to review the existing status of financial and economic profitability of agricultural productions, agricultural incentives, and the comparative advantage of cultivating agricultural commodities by using scarce resources.

4.2 Financial Profitability of Major Cereal and Fiber Crops

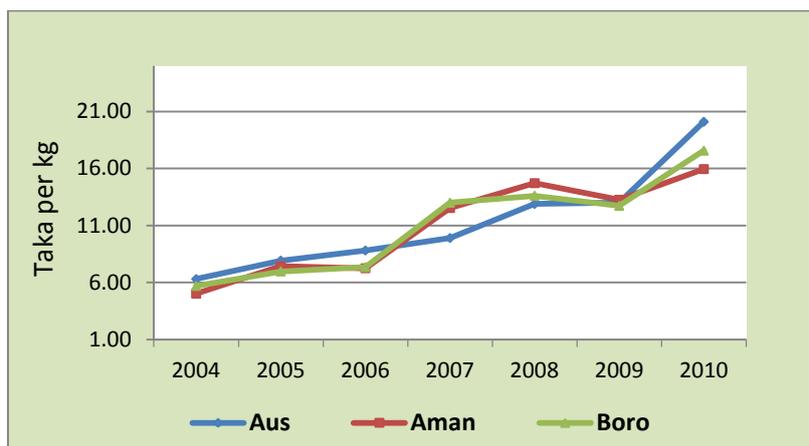
The researchers of BARI, BRRI, and BJRI have conducted several studies on financial profitability on different cereal and fiber crops. This section summarizes their findings in terms of benefit cost ratio (BCR). Research results covered the year 2004 to 2010 for rice, wheat, maize, and jute.

Rice: Rice is the staple food of the population of Bangladesh. Three types of paddy namely *Aus*, *Aman* and *Boro* are cultivated throughout the year since the country is endowed with favourable climate and soils for the production of rice along with many other crops. Most of the cultivated paddy varieties are high yielding. The area and production of rice were 113.587 lakh hectare and 319.75 lakh metric tons respectively (BBS, 2010).

The Agricultural Economics Division of Bangladesh Rice Research Institute (BRRI) collects and analyses primary data on a regular basis. The analyses revealed that the cultivation of rice in Bangladesh is profitable over the years to the farmers since the gross returns are higher than gross costs and BCRs are positive and more than unity respectively (Figures 4.1, 4.2 & 4.3). Of them, according to 2010 data, *Aman* was the most profitable rice crop compared to *Aus* and *Boro* (in terms of BCR). This is mainly due to the fact that *Aman* is still a rain-fed crop and requires no or very little irrigation. In 2010, the highest net return (Tk.14,534/ha) was for *Aman* paddy cultivation (Appendix Table 5) and the lowest (Tk.328/ha) was for *Aus* paddy cultivation (Appendix Table 4). Although the yield and sale price of *Aus* and *Boro* paddy have registered positive growth rates and these rates are higher than the growth rates of production

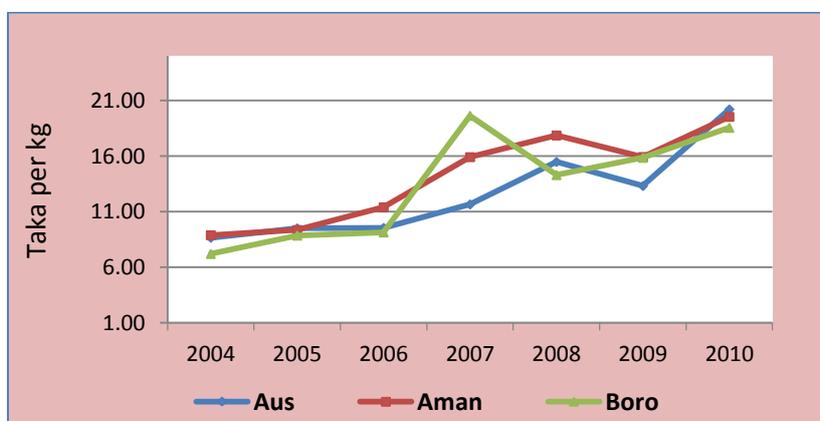
cost. The negative growth rates of net return and BCR implies that farmers' financial profits in producing *Aus*, *Aman* and *Boro* paddy are decreasing year after year due to increase in the cost of inputs (Appendix Tables 4 & 6).

Figure 4.1 Trend of cost of modern variety rice production in Bangladesh



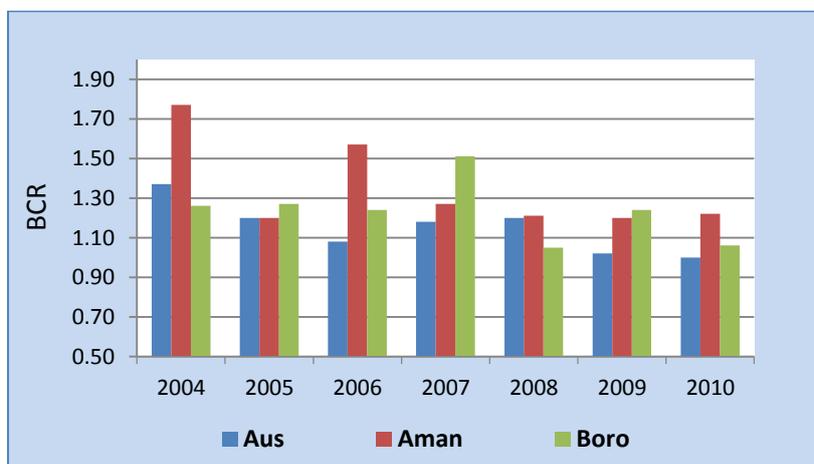
Source: BIRRI (2004-2010)

Figure 4.2 Trend of net return of modern variety rice production in Bangladesh



Source: BIRRI (2004-2010)

Figure 4.3 Benefit cost ratio of modern variety rice production in Bangladesh

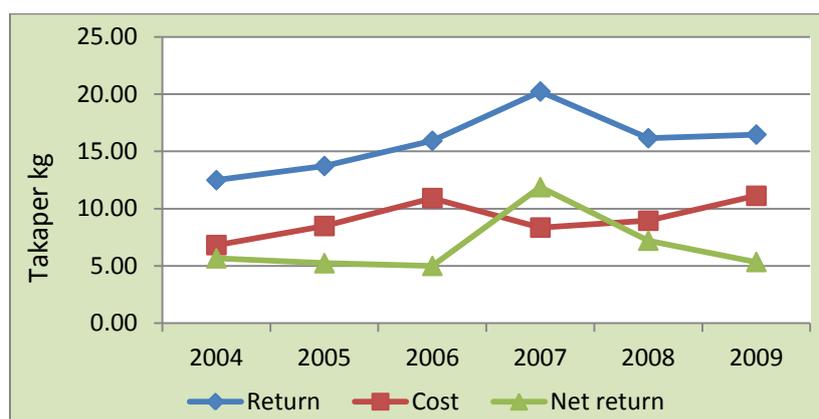


Source: BIRRI (2004-2010)

Wheat: In the 70s wheat was a minor cereal crop in Bangladesh, but today it is the second most important cereal crop in terms of both production and consumption. In 2009-10, the total area and production of wheat were 376.42 thousand hectares and 901490 tons respectively with an average yield of 2.395 t/ha (BBS, 2010). It is produced all over the country during the winter season.

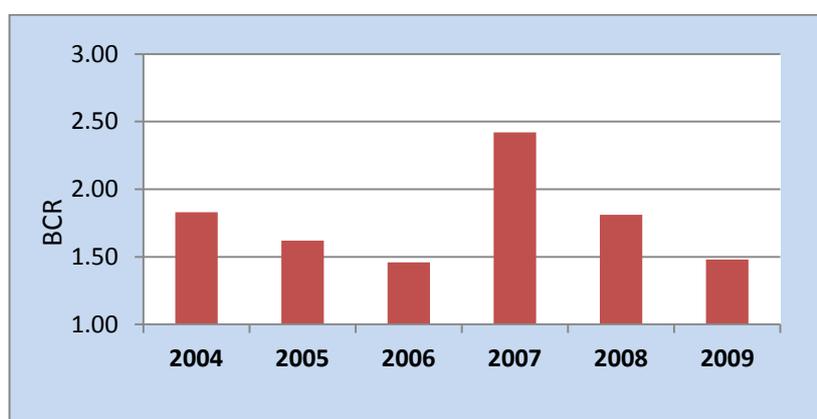
The financial analysis conducted by the Agricultural Economics Division of Bangladesh Agricultural Research Institute (BARI) reveals that wheat is also a profitable crop to the farmers and it is more profitable than rice cultivation, while it is less profitable than maize cultivation. The growth rate of BCR is negative although the growth rate of yield is very much encouraging which is mainly due to introduction of improved variety of wheat and technologies used to produce. The decreasing trend for net return and BCR is mainly due to increase in cultivation cost (Figure 4.4 & 4.5). The growth rate of cultivation cost is higher than the growth rate of sale price (Appendix Table 7).

Figure 4.4 Trend of cost and return of wheat production over time in Bangladesh



Source: BARI (2004-2009)

Figure 4.5 Benefit cost ratio of wheat production over time in Bangladesh

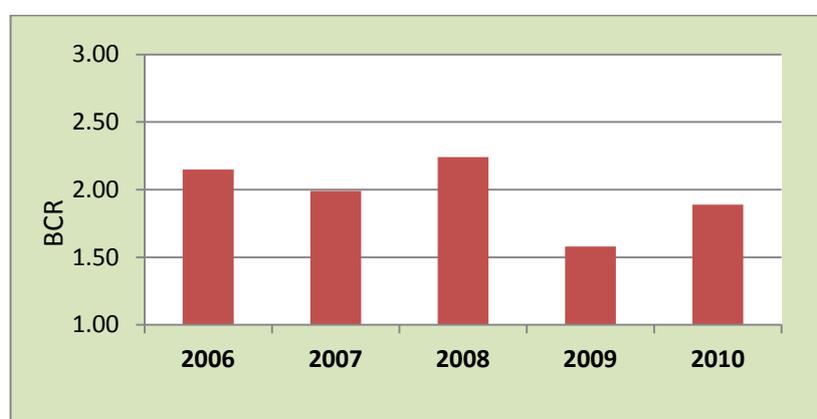


Source: BARI (2004-2009)

Maize: Maize is now considered as a substitute for both rice and wheat since it can be grown in all seasons. It provides food, oil, fuel, fodder and feed. The area under maize cultivation is increasing day by day due to higher demand for maize coming from the feed demand for poultry and livestock production. The genetic yield potential of maize is very high. In 2009-10, the total area and production of maize were 152.23 thousand ha and 887 thousand tons respectively (BBS, 2010).

Financial studies conducted in different years shows that maize is a highly profitable crop to the farmers over the years (Figure 4.6). Its cultivation is more profitable compared to rice and wheat. The profitability of a crop mainly depends on its yield, price and cost of production. On an average, maize growers received Tk. 25,575 to Tk. 40,306 as net return during 2006-2010 (Appendix Table 8). Haque et al. (2007) estimated financial profitability of hybrid maize seed production under different management namely BADC, BRAC and private seed company (Lal teer) and found that hybrid maize seed production is also profitable. The BCR of maize production is the highest among rice, wheat and maize.

Figure 4.6 Benefit cost ratio of maize production over time in Bangladesh



Source: Islam et al. (2006); Haque et al. (2007); Hasan (2008); Moniruzzaman et al. (2009); Karim et al. (2010).

Jute: Jute is a cash crop in Bangladesh. The Agricultural Economics Division of BJRI conducted an economic study of jute cultivation in four districts of Bangladesh (BJRI, 2008). The study revealed that the production of olitorius variety of jute was very much profitable to the farmers of all study areas. On an average, a jute farmer received Tk. 29,485 as net return. The BCR was estimated at 1.75, but BCR for jute production varies across regions of Bangladesh. It is 2.27 in Rajbari while 1.5 in Rangpur (Appendix Table 9).

4.3 Financial Profitability of Major Pulses

The pulses of Bangladesh comprise six major crops namely, lentil, vetch (khesari), blackgram, mungbean, chickpea and pigeon pea. Pulses are important legume crops that play an important role in sustaining the productivity of soils of Bangladesh through centuries. They are generally grown without fertilizer since they can meet their nitrogen requirement by symbiotic fixation of atmospheric nitrogen in the soil (Islam, 1991; Senanayake *et al.*, 1987). Pulses are grown in 233.20 thousand hectares of land which is 3.06% of the total cropped area of the country (BBS, 2010). The production of pulses needs less input with minimum cost. The profitability of major pulses cultivation is discussed below.

Lentil: The common variety of lentil is known as *Masur*. Among different pulse crops, lentil is the most important crop and widely grown in Bangladesh. It ranks first among the pulses in terms of area and consumers' preference and a major source of protein in daily diet. The current area and production of lentil are 77.33 thousand hectare and 72,000 tons respectively (BBS, 2010). Lentil production is profitable to the farmers since it requires less input and minimum cost. During the period from 2000 to 2011, different economic studies revealed that lentil cultivation was remunerative to the farmers since the net returns ranged between Tk. 6712 and Tk. 27838 and the BCRs ranged from 1.51 to 2.26 (Appendix Table 10).

Mungbean: Mungbean is a short duration pulse crop of Bangladesh. Presently, it is being extensively cultivated thrice a year after harvesting of *Rabi* crops including wheat, mustard and

lentil. The area and production of mungbean are about 23077 hectares and 20000 tons respectively with national yield of 867 kg/ha (BBS, 2010). Mungbean cultivation is gaining popularity day by day due to lower cost and higher profit. The financial profitability of mungbean is discussed below.

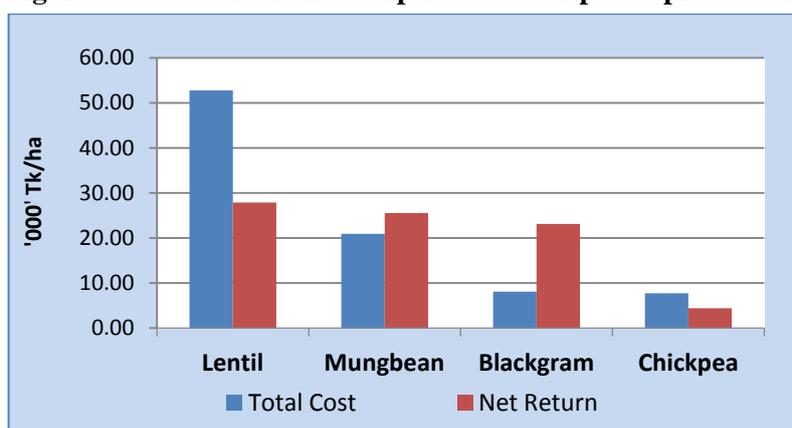
In 2005, the economic study on mungbean cultivation in three districts: Kustia, Jhenaidaha and Barisal revealed that the cultivation of mungbean was profitable to the farmer since the net return and BCR were Tk. 6719 and 1.36 respectively (Miah et al. 2005). In the same year, Alam et al. (2005) estimated the average net return of Tk. 12,843 for the farmers of Faridpur and Pabna. This return was about double compared to previous study mainly due to higher yield and price. Mungbean cultivation was found profitable in the coastal districts including Barisal and Jhalokati because farmers in those areas received Tk. 24,549 as net return (Islam et al. 2008a). A little bit higher net return was also received by the farmers of other two coastal districts namely Noakhali and Patuakhali (Islam et al. 2011a). Both net returns and BCRs were much higher in coastal areas compared to other areas because land use cost was not taken into consideration in profitability analysis (Appendix Table 11).

Blackgram: Blackgram is also a popular pulse crop in some specific areas including Chapai Nawabgonj district of Bangladesh. It is a tropical plant resistant to high temperature. Blackgram can be grown both in summer and winter season. The area under blackgram cultivation during 2009-10 was 25101 hectares with a total production of 24000 tons (BBS, 2010). The cultivation of blackgram is also profitable to the farmer. The net returns received by the farmers ranged from Tk.8445 to Tk.23111 during the period from 2004 to 2007. The BCRs found in 2004 and 2007 were much higher than that in 2005 because land use costs were not included in calculating net return (Appendix Table 12).

Chickpea: Chickpea is an important pulse crop in Bangladesh. It is an important source of human food and animal feed. Chickpea is found to be suitable dryland *Rabi* crop with residual moisture after harvesting *T.Aman* rice in the High Barind Tract (HBT) of Rajshahi division (Islam et al. 2000). The current area and production of chickpea are 7287.45 ha and 6000 tons respectively (BBS, 2010). Chickpea is also a profitable crop in Bangladesh. Different economic studies revealed that farmers in the HBT received a good financial return from little investment on chickpea cultivation. The benefit cost ratios were also impressive to the farmers which were ranged from 1.57 to 3.13 (Appendix Table 13).

Among the pulses crops, lentil required the highest cost of production per hectare followed by mungbean, chickpea and blackgram. On the other hand, lentil produces the highest net return followed by mungbean. Again, the rate of return is the highest for blackgram production because it requires low cost (Figure 4.7).

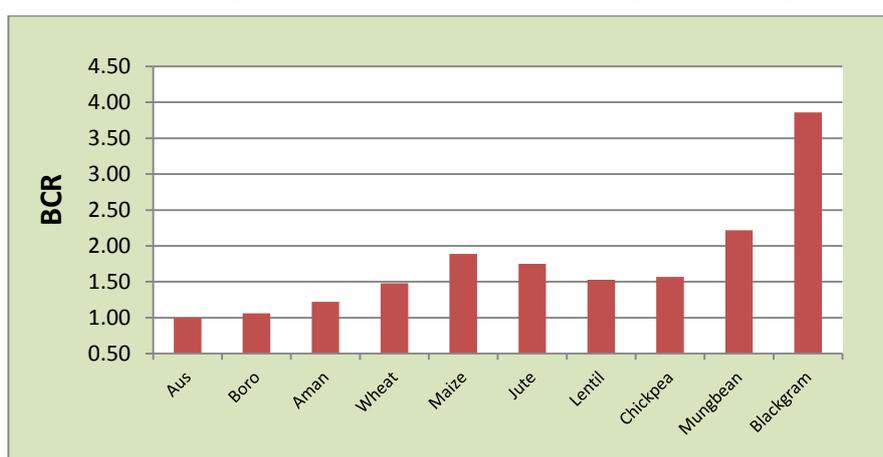
Figure 4.7 Cost and net return per hectare of pulses production



Sources: Rahman et al. 2012; Islam et al. (2011); Islam and Matin (2007); Islam (2008).

In terms of profitability of among the cereal, fibre and pulse crops, it appears that blackgram is the best, which is followed by mungbean, maize, chickpea and lentil (Figure 4.8). The higher BCR was due to lower cultivation cost. Per kilogram production cost of mungbean (Tk 22.1) was much higher compared to blackgram (Tk 8.2) production (Appendix Tables 11 & 12). The lowest BCR is for rice implying that it does not necessarily the best choice among these crops. It should be noted that among the rice crops, *Aman* and jute are grown in the *kharif* season, while the rest are grown in the *Rabi* season. Furthermore, there are significant variabilities in the yields in each of these crops by regions of Bangladesh, and it depends on local weather conditions, soil characteristics, access to markets, access to storage, etc. Variations in these might eventually explain the differences in crop-diversity in these regions. Again, in this figure, we have used 2009-2010 data (whichever is available) and it might also be different in different years based on prices of output and input. However, given the prices in 2009-2010, the following figure explains the relative profitability by crops.

Figure 4.8 Relative profitability of cereal, fibre and pulse crops production



Sources: BRRI (2004-2010); BARI (2004-2009); Karim et al. 2010; BJRI, 2008; Rahman et al. 2012; Islam et al. 2011; Islam and Matin, 2007; Islam, 2008.

4.4 Financial Profitability of Major Oilseed Crops

The major oilseed crops in Bangladesh are mustard, sesame, groundnut, and linseed. The total area and production of oilseeds are about 366 thousand hectares and 786 thousand tons respectively (BBS, 2010). Mustard is the principal oilseed crop of Bangladesh. It occupies more than 75% of the total oil-seed cropped areas. It grows during the *rabi* season (October-February). Sesame is the second most important oilseed crop in Bangladesh. In 2009-10, the area under sesame was produced on 35,567 hectares of land and the production was around 32,306 tons (BBS, 2010). Soybean is another important oilseed crop in the country which is used in several forms. In Bangladesh, it is produced in several pockets of the country. Soybean is also used in the poultry and fisheries industries as feed. The other oilseed crops namely groundnut, sunflower and linseed are grown in some specific areas of the country.

Economic studies show that the cultivations of oilseed crops are profitable at farm level. The net returns received from HYV mustard, sesame and groundnut cultivation were Tk.35,676/ha, Tk.13,947 and Tk.22,773/ha which were significantly higher than their corresponding local varieties. The average net return received from soybean was Tk.13,157/ha. The average rates of returns (BCR) for mustard, sesame, soybean and groundnut cultivation were more than one implying that the farm level cultivations of these oilseed crops were profitable to the farmers (Table 4.1). The present BCR (1.65) of soybean cultivation was much higher than the BCR (1.44) calculated by Talukdar (1999).

Table 4.1 Financial profitability of oilseed cultivation at farm level in Bangladesh

Cost and return	Mustard		Soybean	Sesame		Groundnut	
	HYV	Local		HYV	Local	HYV	Local
Total cost (Tk/ha)	29102	26510	20273	29496	28619	56602	42496
Yield (kg/ha)	1491	979	1537	1210.26	982.5	2238	1540
Gross return (Tk/ha)	64778	41395	33430	43443	34829	79375	53178
Main grain	62054	38936	31496	43443	34829	79375	53178
By-product	2724	2459	1934	--	--	--	--
Net return (Tk/ha)	35676	14885	13157	13947	6210	22773	10682
Rate of return	2.23	1.56	1.65	1.48	1.22	1.40	1.25

Source: Miah and Alam (2008); Miah et al. (2008); Akter et al. (2010); Salam and Bakr (2009)

4.5 Financial Profitability of Major Spices Crops

Spices are popular as cash crops in Bangladesh. It has multipurpose uses. The major spices grown in the country are onion, garlic, chili, turmeric and ginger. Onion, garlic and chili are short duration crop, whereas turmeric and ginger are long duration crops. Different economic studies showed that the cost of production varied in a wide range among the spices produced in the country. Unlike other agricultural crops, spice producers receive concessional credits at the rate of 2% annual interest from banks in Bangladesh since it is relatively most costly to produce spices. The financial profitability of major spices cultivation is discussed below.

Onion: Onion is an important spice crop of Bangladesh widely grown in the winter. It is used as spice and vegetable in various ways in all curries, fried, boiled, baked and for other purposes. It has medicinal values also. Onion stands first among the spices crops in the country covering 1,17,814 ha of land with 872 thousand tons of production (BBS, 2010). The yield of onion is very low in Bangladesh as compared to the world average (FAO 1999). It is a profitable crop to all categories of farmers. Rahman (1998) found onion cultivation highly remunerative to all categories of farmers at Rajshahi district. In 2000, the Spices Research Centre of BARI also conducted economic study on onion production and found it highly profitable to all categories of farmers. The average cost, net return and BCR of onion production were Tk. 41827/ha, Tk. 96709/ha and 3.31 respectively (Hasan, 2000). Some recent economic studies also reveal that onion cultivation is highly profitable but the net profit per hectare and BCR have decreased in recent years due to increase in input prices (Appendix Table 14).

Garlic: Garlic has been an ingredient in our food as a condiment, and for medicinal purposes for time immemorial. The crop is intensively cultivated during the winter season of Bangladesh. The area under garlic production is about 37,247 hectares with production of 164 tons (BBS, 2010). Both the area and production of garlic are increasing year after year due to its higher demand and profit.

Different economic studies indicated that garlic cultivation is a profitable enterprise that can contribute greatly to increase farmer's income. Baree et al. (2006) estimated the average cost and net returns of Tk.7,043 and Tk. 75,452 per hectare for garlic production in Pabna district respectively. Islam (2010) and Islam and Rahman (2011) also found that garlic production was highly remunerative to the farmers of the study areas. It is more profitable than many other crops since the benefit cost ratios of its cultivation were more than two except in 2009

(Appendix Table 15). Haque et al. (2009) found that garlic cultivated with zero tillage was also profitable and this cultivation needed low investment.

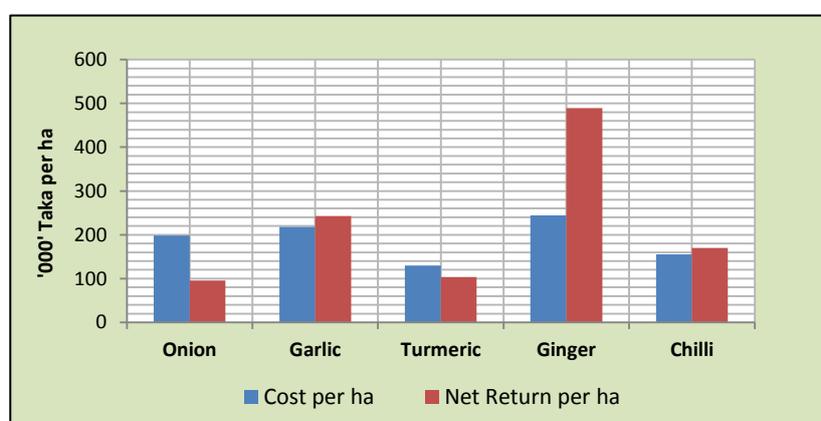
Turmeric: Turmeric is an important spice crop widely grown in the summer season. Different types of turmeric including Sinduri, Dimla and Pabna are cultivated throughout the country. The production of turmeric is increasing day by day due to its higher demand and profitability. Turmeric is also a profitable crop. Islam and Rahman (2011) and Karim (2011^a) estimated the profitability of turmeric production at farm level. Their study showed that turmeric cultivation was highly profitable to the farmers since the per hectare net returns received by the farmers were Tk.1,03,617 and Tk.4,35,017 respectively. The output-input ratios were also higher than unity (Appendix Table 16).

Ginger: The production of ginger is more profitable compared to other spices production. Nahar (2010) conducted an economic study on ginger cultivation and found that ginger cultivation was highly profitable to the farmers since they received Tk. 3,28,512/ha as net return and the rate of return was 2.62. Another two studies conducted by Islam and Rahman (2011) and EPC (1997) also supported this profitability scenario (Appendix Table 17).

Chili: Chili is one of the most frequently used spices in Bangladesh. The total area and production of chili are 87.044 thousand ha and 109 thousand tons respectively (BBS, 2010). In the case of green chili, the average cost of production and net returns were estimated at Tk.78,950 and Tk.73,164 respectively in 2010. The dry chili producer received higher return compared to green chili production. The BCRs observed from different studies were more than one indicating that farmers received impressive income from chili cultivation (Appendix Table 18).

Figure 4.9 summarizes the cost and return per hectare of spices production in Bangladesh. It shows that in terms of costs per hectare, ginger has the highest costs, followed by garlic, onion, chili and turmeric. In terms of net return per hectare, the order of spices from highest to lowest are ginger, garlic, chili, turmeric and onion. Clearly, the orders are different but at the same time, not all lands are suitable for the production of all spices crops and hence at the ground level, the choice of spices for production might be different by regions.

Figure 4.9 Cost and net return per hectare of spices production, 2011



Sources: Haque et al. 2011; Islam and Rahman, 2011

4.6 Financial Profitability of Major Vegetables

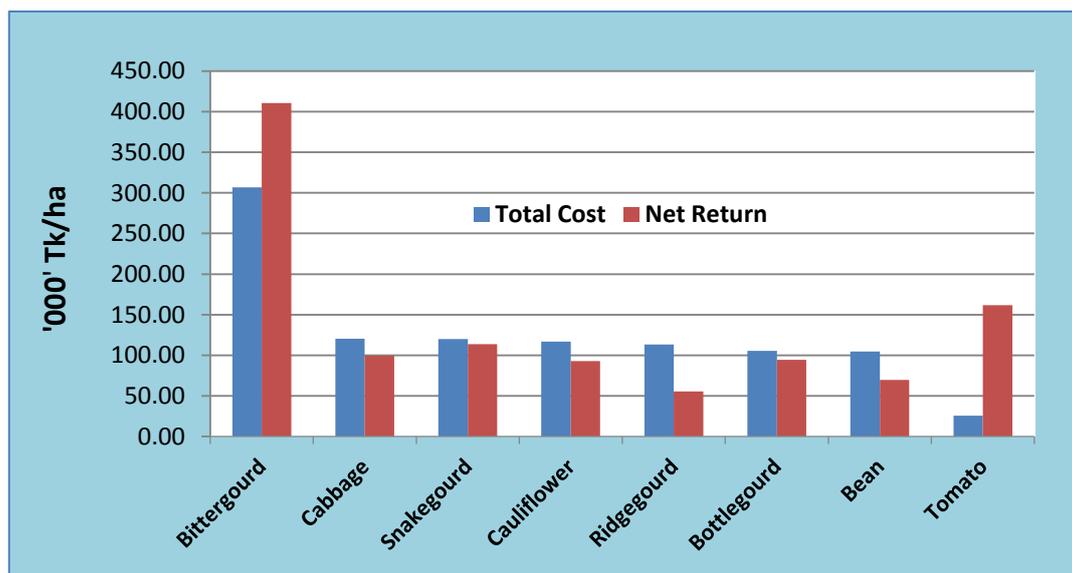
The weather of Bangladesh allows growing a variety of vegetables round the year. About 100 types of vegetables of both indigenous and exotic origin are grown in the country. These

vegetables are categorized by summer vegetables (May to October), winter vegetables (November to April) and all-year vegetables. Various cucurbits, cowpea, hyacinth bean, stem amaranth, several aroids and Indian spinach are generally grown in the summer season. Major winter season vegetables are tomato, cabbage, cauliflower, Chinese cabbage, brinjal, carrot, spinach, bottle gourd, bush bean and radish. The year round vegetables include okra, heat-tolerant tomato, brinjal, carrot, spinach, and leafy vegetables. The profitability of different vegetables is discussed in the following sub-sequent sections.

Potato: Potato² is the third largest food crop in Bangladesh. It is also a cash intensive crop to the farmer. Potato is used as food as well as vegetable by all the classes of people. Haque et al. (2005) estimated the profitability of potato cultivation under Integrated Crop Management (ICM) and Farmers' Production Practice (FPP) at Bogra, Comilla, Munshiganj and Rajshahi districts. The net returns received by the farmers ranged from Tk. 65,600 to Tk. 1,05,363 for ICM and Tk. 12,845 and Tk. 74,271 for FPP. The BCRs ranged from 1.85 to 2.77 for ICM and 1.15 to 2.16 for FPP. The other economic studies conducted during the period from 2008 to 2010 revealed that the cultivation of potato at farm level was highly profitable to the farmers (Appendix Table 19).

Other vegetables: Various economic studies showed that the financial profitability of all types of vegetables was found to be very much remunerative to the farmers. Among the vegetables, bitter gourd produced the highest net return followed by tomato and snake gourd (Figure 4.10). The other highly profitable vegetables are brinjal, tomato, cabbage and cauliflower. The highest BCRs (more than two) were calculated for white gourd, okra and bitter gourd (Appendix Table 20).

Figure 4.10 Cost and net return per hectare of vegetables production, 2009-2010



Sources: Karim and Mustofa, 2010; Akter, 2009; Khayer, 2009; Parvin, 2010

4.7 Financial Profitability of Major Fruits

Mango: Mango is one of the important seasonal fruits of Bangladesh. It ranks first in terms of consumers' preference and consumption. The area under mango cultivation was about 32011

²Although potato is a staple food in many countries, in Bangladesh it is regarded as a variety of vegetables in terms of their use in our food.

ha with a total production of 1047849 metric tons (BBS, 2010). Mango cultivation is profitable to the farmers. The financial analysis shows mango cultivation is profitable because the discounted BCR is 2.25 and IRR is 19.5% (Appendix Table 21).

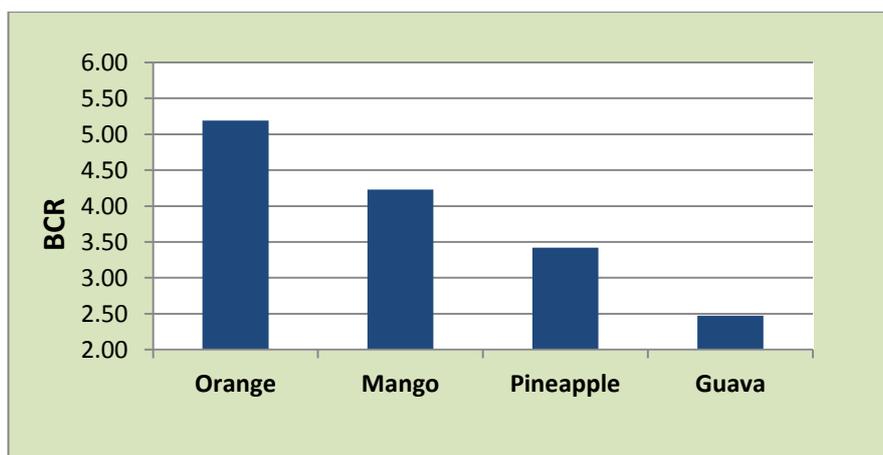
Orange: Orange is a popular and attractive citrus fruit in Bangladesh. It is produced in a small-scale in the hills and Sylhet district. Most of its demand is generally met through importation from foreign countries including India and China. Orange farmers have taken this cultivation as a profitable venture. The economic analysis revealed that the initial cost of orange plantation was Tk. 52930 and the garden needs maintenance costs up to 3rd year before fruiting. Farmers can harvest fruit from forth year to 20th year. The overall financial analysis shows that it is highly profitable since its discounted BCR was 3.0 and IRR was 73% (Appendix Table 22).

Guava: Guava is one of the most common and popular fruits generally grown in the homestead areas of Bangladesh. The total production of guava in the country is 181 thousand MT (BBS, 2010). Guavas are rich in dietary fiber, vitamins A and C, folic acid, and the dietary minerals, potassium, copper and manganese. Having a generally broad, low-calorie profile of essential nutrients, a single common guava (*P. guajava*) fruit contains about four times the amount of vitamin C as an orange (<http://en.wikipedia.org/wiki/Guava>). An economic study conducted in three guava producing areas revealed that guava cultivation was profitable since the growers received Tk.41367 as net return (Haque et al. 1996). Another study conducted in Natore and Gazipur district also revealed that guava cultivation at farm level is highly profitable (Appendix Table 23).

Pineapple: It is a popular juicy fruits extensively grown in the hilly regions of Bangladesh. Its cultivation is very much profitable to the farmer. Economic analysis revealed that the cultivation of pineapple in hill areas was profitable since its discounted BCR, NPV and IRR were 1.82, Tk.198,104 and 56.77% respectively (Appendix Table 24). Pineapple cultivation under contour system was much profitable compared to traditional system. A 3-year demonstration showed that pineapple cultivation under both traditional and contour systems were profitable. The net return from the contour planting system was 58.3% higher than that of the traditional cultivation (Appendix Table 25).

The profitability scenario clearly shows that among above four fruits, the highest rate of return (undiscounted BCR) was received from orange cultivation followed by mango, pineapple and guava cultivation (Figure 4.11).

Figure 4.11 Benefit cost ratio of fruits production in Bangladesh



Sources: Hossain et al. 2011; Matin et al. 2009; Rahman et al. 2003

Jackfruit: Jackfruit is the national fruit of Bangladesh. It is also an important cash-generating crop in many areas of the country. The jackfruit trees not only provide suitable ecology for the under storey crop but also produce other basic requirements of the growers such as food, fodder, fuel wood and timber. It is rich in vitamin A and C, contains moderate qualities of minerals and high qualities of protein, calcium, thiamin, riboflavin and carotene than banana, but less in nutrition to mango (Hossain *et al.*, 1979).

The study conducted by Hasan *et al.* (2008) revealed that the initial costs for jackfruit and pineapple plantation included saplings, suckers, bamboo stick, fertilizers, land and pit preparation, and land rent which was Tk. 40158/ha. Inter-temporal budget for jackfruit-pineapple agroforestry production system showed that the cash flow in the first year was negative, but it became positive from second year and it continued in subsequent years. The discounted BCR (1.51), net present value (Tk.1,53,720/ha) and internal rate of return (51%) clearly indicated the profitability of Jackfruit-pineapple agroforestry production system (Appendix Table 26).

Banana: Banana is the cheapest plentiful fruit in Bangladesh containing essential nutrients including minerals and vitamins. It is cultivated throughout the country both as sole crop and intercropping with potato, brinjal, cucumber, radish and ginger. The present area and production of banana are 53.97 thousand hectares and 818.25 thousand MT respectively (BBS, 2010). Sagar and Champa are the two important common varieties of banana extensively cultivated in Bogra district. Economic study showed that the cultivations of these varieties were highly profitable at farm level since the farmers received a handsome return from its cultivation and the average BCR was estimated at 2.85 (Table 4.2).

Table 4.2 Profitability of different varieties of banana cultivation

Particulars	Year: 2000						1997
	Sagar		Champa		Average		
	WI	WOI	WI	WOI	WI	WOI	WOI
Yield (bunches/ha)	2655	2644	1954	2105	2305	2375	14 ton
Average price (Tk/bunch)	43.00	52.40	46.25	49.25	44.63	50.83	4.96/kg
Gross returns (Tk/ha)	172120	138546	116188	103671	144757	120721	69449
<i>Banana</i>	114165	138546	90373	103671	102872	120721	69449
<i>Sucker</i>	892	--	--	--	446	--	--
<i>Intercrop</i>	57063	--	25815	--	41439	--	--
Total variable cost (Tk/ha)	74019	46999	47052	38012	60536	42507	21095
Gross margin (Tk/ha)	98101	91547	69136	65659	84221	78214	48353
BCR (over variable cost)	2.33	2.95	2.47	2.73	2.39	2.84	3.29

Note: WI= With intercrop, WOI = Without intercrop

Source: Rahman *et al.* 2000. EPC, 1997

Papaya: Papaya is a popular and year-round fruit in Bangladesh. It is rich in anti-oxidants, (B vitamins, folate & pantothenic acid), minerals (potassium & magnesium), fiber and digestive enzyme (www.gurumaa.com). The study conducted by EPC (1997) revealed that the financial net return of papaya cultivation was Tk. 23126 per hectare. The BCR was 2.48 which found to be much higher compared to many other crops in Bangladesh (Table 4.3).

Table 4.3 Profitability of papaya production in the study areas

Particular	Cultivation year 1997
Papaya yield (Ton/ha)	18
Average price (Tk/kg)	2.16

Gross returns (Tk/ha)	38775
Total cost of production (Tk/ha)	15649
Net return (Tk/ha)	23126
Benefit Cost Ratio	2.48

Source: EPC, 1997.

4.8 Financial Profitability of Livestock and Poultry Farming

Dairy cow rearing: Rearing of dairy cows is an important source of income and employment for the agricultural labour force of Bangladesh. Different studies found dairy cow rearing to be a profitable business (Rahman et al, 1993; Rahman and AkteruzzAman, 1994; AshrafuzzAman and Rahman, 1995; Alam et al. 1995; Jabbar et al.1997; Jahan, 1995; Rahman et al. 2000). The incomes from sale of milk, dung, draft power and appreciation of calf together constitute gross return of a dairy farm. Again, feed, human labour, and veterinary care are the major costs. The studies that were conducted between 2002 and 2009 revealed that the rearing of dairy cows of both cross-breed and local breed are profitable since the BCRs were more than one and ranged from 1.37 to 1.90 (Appendix Table 27).

Beef cattle fattening: Cattle fattening for beef production is a profitable agribusiness to many households in Bangladesh. A large number of households involved in cattle fattening just 3-4 months before Eid-ul-Azha (Muslim festival), when they can sale fattened animals with higher price. Many NGOs provide short-term loan for this purpose. Generally, lower age and weak health cattle are considered for fattening for a period of 3-7 months. The principal costs incurred for beef fattening are balanced feed and veterinary care. Different studies revealed beef cattle fattening was a profitable business. Hasan et al. 2011 estimated average net return of Tk. 2533 for a fattened cattle Brahmanbaria and Kishoregonj districts. Sarma and Ahmed (2011b) estimated net return of Tk. 5500 per cattle (Appendix Table 28).

Goat rearing: Goat is one of the sub-sectors of livestock and is called *poor men's cow* in Bangladesh. They are generally reared in traditional backyard allowing them to graze in surrounding areas of households. The economic value of goats is accounted for their good quality, flavoury tender meat, prolificacy, high fertility, early sexual maturity and good quality skin (Khan, 2005). It helps reducing poverty among rural population and earning foreign exchange. Different economic studies conducted during 2005-2008 revealed that a goat could earn Tk. 727 to Tk. 2111 per year depends on the scale of farming. The BCRs of goat farming were found to be more than unity implying that goat farming was a profitable business in the country (Appendix Table 29).

Broiler: Due to increasing demand for chicken and availability of readymade poultry feed a large number of broiler farms has been established and these are running profitably in most urban and peri-urban areas of Bangladesh. An attempt has been made to discuss the profitability of broiler production in the country. The gross return of a boiler farm includes the income from sale of live birds, litter & excreta and used gunny bags. Again, the major costs incurred for a broiler farm are day-old chick, feed, medicine, litter, electricity, transportation and labour. The economic studies conducted in the past reveal that the broiler farming in any scale was a profitable business and the level of return varied to some extent due to price of input and output (Appendix Table 30).

Layer farm: A large number of layer farms have been established on commercial basis in and around the cities and towns due to increasing demand for eggs, availability of readymade feed and other concerned developments and are operated under intensive management (Miah, 2002). The rising trend in layer farming in Bangladesh is quite encouraging. The financial profitability of layer farming is discussed below based on literature review. The gross return of

a layer farm includes the income from sale of eggs, culls bird, litters and used gunny bags. On the other side, the major costs incurred for a layer farm are day-old chick, feed, medicine, litter, electricity, transportation and labour. Layer farming was a profitable venture since the BCRs were more than unity in all the study years (Appendix Table 31).

4.9 Financial Profitability of Fish Farming

Fishery is one of the sub-sectors of agriculture. This sector plays an important role in developing agro-based economic condition of Bangladesh through supplying protein, increasing employment opportunities, and earning foreign currencies. Pond fish culture has been received due attention to meet the growing demand for fish for the increasing population of the country. Islam and Miah (1999) reviewed DoF and NGO fisheries schemes and found the schemes profitable. Islam (2000) found in his study that the returns per taka investment in pond fish farming were Tk.1.25 and 2.83 for men and women contact farmers respectively. The study conducted by Biswas et al. (2000) also indicated that pond fish culture was highly profitable since the net return of per taka invested was 1.43. The estimated profitability scenario of different fish farming studies conducted during 2006-2011 revealed that fish farming with different species of fishes were profitable to the farmers (Appendix Table 32).

4.10 Economic Profitability of Different Crop Production

The social or economic profitability of cultivating crops in Bangladesh deviates from financial profitability due to various reasons including distortion in input and output markets, externalities, and government policy interventions. The economic profitability estimates can help in deriving meaningful policy conclusions on how to reorient farming systems toward socially profitable pattern. An attempt has been made to review the economic profitabilities of different crops which were estimated earlier and has been discussed in the following sections.

Rice crops: Mahmud et al. (1994) and Shabuddin and Dorosh (2002) estimated the net economic profitability of different crops at both import and export parity prices (Table 4.4). Their studies revealed that the economic returns calculated for all varieties of rice were much higher at import parity price and non-traded situation, but the picture found to be completely different at export parity price. When export parity price was considered, the economic returns found to be much lower than its corresponding financial returns.

Cash crops: Both the above mentioned studies estimated the economic profitability of jute and tobacco production at export parity prices, whereas import parity prices were considered for sugarcane and cotton cultivation. The economic profitability of jute and tobacco was much higher than its financial returns. Whereas, reverse situation was observed in the case of sugarcane and cotton production.

Oilseed and pulse crops: Mustard occupies the largest share of oilseed production in Bangladesh. Along with other two oilseed crops, mustard showed negative economic returns at import parity price, but financial profitability of these crops were positive. Unlike oilseeds, pulses appear to be strongly competitive as a non-irrigated *Rabi* crops in terms of both financial and economic profitability (Mahmud et al.1994). At import parity price level, the economic profitability of pulses was higher compared to financial profitability.

Spices crops: The economic profitability of chili and onion was much lower than their financial returns. Because of higher domestic prices, spices especially chili is highly competitive with other *Rabi* crops.

Vegetable crops: Potato is extensively used as vegetable in Bangladesh. Mahmud et al. (1994) treated potato as a non-traded product for economic evaluation. But Shabuddin and Dorosh (2002) estimated its potential economic return under alternative import and export regimes. In both the studies the economic profitability was much higher than its financial returns. Other vegetables appeared to be highly competitive in terms of both financial and economic returns in their studies. The economic profitability of vegetable production for export appears to be amazingly high as compared with most other crops (Table 4.4).

Table 4.4 Net economic profitability of different crops cultivation in Bangladesh

(Figures in Tk/ha)

Crops	Year: 1990-1991			Year: 1996/97-1998/99		
	Import parity	Non-traded	Export parity	Import parity	Non-traded	Export parity
Rice crops:						
<i>Aus</i> (HYV)	12681	8833	4738	10763	648	3428
<i>Aus</i> (Local B.)	3383	-1605	-306	1757	-258	-1838
<i>Aman</i> (HYV)	16804	12262	7429	19970	14177	9644
<i>Aman</i> (Pajam)	12824	8997	4924	17413	12056	7863
<i>Aman</i> (Local T.)	8515	5856	3019	10105	6682	4003
<i>Boro</i> (HYV)	16485	11132	5442	18172	12047	7254
<i>Boro</i> (Local T.)	9170	6554	3763	9245	6156	3758
Wheat	1757	--	--	6540	--	--
Cash crops:						
Jute	--	--	10822	--	--	11140
Tobacco	--	--	83537	--	--	91212
Sugarcane	3106	--	--	33323	--	--
Cotton	16625	--	--	16886	--	--
Oilseeds:						
Mustard (oil)	-2907	--	--	-2747	--	--
Sesame (oil)	-6692	--	--	-6463	--	--
Linseed (oil)	-719	--	--	-597	--	--
Pulses:						
Lentil	10131	--	6320	14543	--	9715
Chickpea	7698	--	--	12184	--	7826
Vetch	7979	--	--	8551	--	5454
Spices:						
Chili	8522	--	--	6549	--	--
Onion	36697	--	--	86322	--	--
Vegetables:						
HYV Potato (fresh)	--	26402	--	184665	81702	26788
Brinjal	--	48246	274623	--	--	322014
Radish	--	21608	241102	--	--	351669
Cucumber	--	37858	191219	--	--	194865
Barbati	--	46245	167244	--	--	207248
Arum	--	51305	--	--	--	328966
Tomato	--	88775	--	--	--	553940
Cabbage	--	50657	--	--	--	498056

Source: Year 1990-91 (Mahmud et al., 1994); Year 1996/97-1998/99 (Shabuddin and Dorosh, 2002)

4.11 Impact of Policies on Agricultural Incentives

Alam (2005) and Rashid et al. (2009) estimated the impact of government policy on the financial incentives for the production of selected commodities by calculating Nominal Protection Co-efficient (NPC); Nominal Rate of Protection (NRP); Effective Protection Co-efficient (EPC) and Effective Rate of Protection (ERP). They used f.o.b. world prices at the port of a significant exporting country and brought these prices to the import parity level assuming that imports compete with domestic production at the producer level. A NPC of greater than one indicates that the government has protected domestic production by raising its financial price in the domestic market above its economic price. Again, an EPC of less than one for a crop implies that the domestic market for that crop is not protected and the crop requires substantial protection in future for import substitution.

Table 4.5 Nominal rate of protection of rice crops at official exchange rate

Year	Coarse rice				Aromatic fine rice				Non-aromatic fine rice			
	Import parity		Export parity		Import parity		Export parity		Import parity		Export parity	
	NPC	NRP	NPC	NRP	NPC	NRP	NPC	NRP	NPC	NRP	NPC	NRP
2005	1.024	0.024	1.186	0.186	0.577	-0.423	0.440	-0.560	0.438	-0.562	0.970	-0.029
2006	1.087	0.087	1.262	0.262	0.423	-0.577	0.527	-0.473	0.440	-0.560	1.042	0.042
2007	1.044	0.044	1.190	0.190	0.408	-0.592	0.501	-0.499	0.406	-0.594	0.772	-0.227
2008	0.915	-0.085	1.000	0.000	0.458	-0.542	0.453	-0.457	0.437	-0.563	0.444	-0.555
2009	0.953	-0.047	1.046	0.046	0.362	-0.638	0.449	-0.551	0.463	-0.537	0.644	-0.355

Source: Rashid et al. 2009

Data presented in Table 4.5 shows that NPCs were less than one and NPRs were negative for all types of rice for most of the years for both import and export parity. It means that domestic rice production was taxed and consumers were subsidized. Again, the border price of wheat, maize, potato and lentil at producer level measured at official exchange rate was mostly higher than the domestic producer price (Table 4.6). They reexamined the estimated NPCs by workout EPCs. The EPCs shown in Table 4.7 were mostly less than one and ERPs were negative for the aforesaid crops, except coarse rice production during 2005-07. This implies the domestic market of those commodities was not protected. Domestic production of these commodities may require substantial protection in future for import substitution. In another words, there is scope of producing these crops for import substitution and export promotion.

Table 4.6 Nominal rate of protection for some non-rice crops at official exchange rate

Year	Wheat		Maize		Potato		Lentil	
	Import parity		Import parity		Import parity		Import parity	
	NPC	NRP	NPC	NRP	NPC	NRP	NPC	NRP
1974-2001	-	-	0.836	-0.164	0.351	-0.649	0.784	-0.216
2005	0.889	-0.110	0.892	-0.108	0.339	-0.660	0.751	-0.248
2006	0.993	-0.006	0.908	-0.092	0.324	-0.675	0.675	-0.324
2007	0.918	-0.081	0.790	-0.210	0.310	-0.689	0.720	-0.279
2008	0.735	-0.264	0.583	-0.417	0.297	-0.702	0.653	-0.346
2009	0.815	-0.184	0.595	-0.404	0.286	-0.713	0.430	-0.569

Source: Rashid et al. 2009; Data for year 1974-2001 (Alam, 2005)

Table 4.7 Effective rates of protection for selected agricultural commodities

Year	Coarse rice				Aromatic fine rice				Non-aromatic fine rice			
	Import parity		Export parity		Import parity		Export parity		Import parity		Export parity	
	EPC	ERP	EPC	ERP	EPC	ERP	EPC	ERP	EPC	ERP	EPC	ERP
2005	1.06	0.06	1.24	0.24	0.43	-0.57	0.64	-0.36	0.85	-0.15	0.43	-0.57
2006	1.13	0.13	1.33	0.33	0.43	-0.57	0.63	-0.37	0.42	-0.58	0.52	-0.48
2007	1.08	0.08	1.24	0.24	0.40	-0.60	0.57	-0.43	0.40	-0.60	0.49	-0.51

2008	0.94	-0.06	1.03	0.03	0.43	-0.57	0.44	-0.56	0.45	-0.55	0.54	-0.46
2009	0.94	-0.06	1.04	0.04	0.41	-0.59	0.58	-0.42	0.34	-0.66	0.43	-0.57

Source: Rashid et al. 2009

Table 4.7 Contd.....

Year	Wheat		Maize		Potato		Lentil	
	Import parity		Import parity		Import parity		Import parity	
	EPC	ERP	EPC	ERP	EPC	ERP	EPC	ERP
2005	0.92	-0.07	0.94	-0.05	0.31	-0.68	0.75	-0.24
2006	1.04	0.04	0.95	-0.04	0.30	-0.69	0.69	-0.32
2007	0.94	-0.05	0.79	-0.20	0.28	-0.71	0.72	-0.27
2008	0.73	-0.27	0.55	-0.44	0.27	-0.72	0.65	-0.34
2009	0.80	-0.19	0.54	-0.45	0.24	-0.75	0.38	-0.61

Source: Rashid et al. 2009

4.12 Comparative Advantages of Cultivating Crops

A measure of comparative advantage was used in many economic studies to examine the efficiency of using resources to produce a product at home instead of importing the same from abroad. It is known as domestic resource cost (DRC) which is equals to the cost of domestic resources and non-traded inputs for producing one unit of output less tradable inputs. A DRC ratio of less than one implies that the production is efficient and makes positive contribution to domestic value added. In contrast, a DRC of greater than one indicates that the commodity should not be produced domestically instead of importation.

Shabuddin and Dorosh (2002) estimated DRC for producing different rice and non-rice crops at import, export and non-traded levels during 1996/97-1998/99. The estimated DRCs of various rice (except local varieties of *Aus* and *Aman*) were less than unity under import parity price. This implies that the government should give emphasis on attainment of self-sufficiency in rice production rather than import from foreign countries. Again, the DRCs under the export parity price were mostly greater than one (excepting HYV *Aman*) indicating that there was hardly any economic ground of production of rice for export from a strictly efficiency point of view (Table 4.8). Since Bangladesh has attained self-sufficiency in rice production, the country can take initiative for rice export so that producers can harvest a share of export benefit in terms of higher price to some extent. This policy decision is supported by the recent study of Rashid et al. (2009).

Rashid et al. (2009) estimated DRC for rice, wheat, maize, potato and lentil production for the period of 2005 to 2009 at import and export parity prices (Table 4.9). The estimated DRCs for rice production were less than unity under both import and export parity prices implying that the country had comparative advantage in rice production for import substitution and export promotion. Again, the other estimates of DRCs were also less than unity at import parity price indicating Bangladesh had comparative advantage in producing wheat, potato and lentil and would be highly efficient for import substitution. These results were also supported by the findings of Talukder et al. (2004).

Karim et al. (2011) estimated DRCs of producing thirteen types of vegetables using f.o.b. prices at airport. The estimated values were less than unity indicating that Bangladesh had comparative advantage in vegetable production for import substitution and export promotion (Table 4.10).

Table 4.8 Domestic resource costs of different crops in Bangladesh: 1996/97-1998/99

Crops	Domestic Resource Costs		
	Import parity	Non-traded	Export parity
<i>Aus</i> (HYV)	0.82	1.04	1.30
<i>Aus</i> (Local B.)	1.25	1.55	1.91
<i>Aman</i> (HYV)	0.61	0.75	0.93
<i>Aman</i> (Pajam)	0.67	0.84	1.03
<i>Aman</i> (Local T.)	1.04	1.28	1.57
<i>Boro</i> (HYV)	0.70	0.89	1.12
<i>Boro</i> (Local T.)	0.93	1.15	1.40
Wheat	0.89	--	--
Jute	--	--	0.80
Mustard	1.25	--	--
Sesame	1.75	--	--
Linseed	0.86	--	--
Lentil	0.43	--	0.56
Chickpea	0.44	--	0.57
Vetch	0.62	--	0.81
Chili	1.11	--	--
Onion	0.25	--	--
HYV Potato (fresh)	0.18	0.33	0.63
Brinjal	--	--	0.10
Radish	--	--	0.07
Cucumber	--	--	0.11
Barbati	--	--	0.12
Tomato	--	--	0.05
Cabbage	--	--	0.05

Source: Shabuddin and Dorosh, 2002

Table 4.9 Domestic resource costs of selected crops in Bangladesh, 2005-2009

Crops	2005	2006	2007	2008	2009
Fine rice					
Import parity	0.570	0.621	0.612	0.279	0.561
Export parity	0.857	0.900	0.882	0.285	0.800
Aromatic rice					
Import parity	0.474	0.347	0.325	0.131	0.406
Export parity	0.474	0.188	0.153	0.108	0.354
Coarse rice					
Import parity	0.681	0.738	0.680	0.482	0.433
Export parity	0.798	0.868	0.783	0.529	0.477
Wheat					
Import parity	0.704	0.659	0.513	0.352	0.822

Maize					
Import parity	1.149	1.067	0.822	0.535	0.568
Potato					
Import parity	0.374	0.380	0.385	0.391	0.388
Lentil					
Import parity	0.308	0.258	0.259	0.221	0.429

Source: Rashid et al. 2009

Table 4.10 Domestic resource costs of different vegetable crops in Bangladesh, 2005-06

Vegetables	Cost of non-traded inputs (Tk/MT)	Costs of traded inputs (Tk/MT)	f.o.b price at airport (Tk/MT)	DRC
1. Snake gourd	2379	293	15600	0.16
2. Brinjal	4177	1045	25250	0.17
3. Yardlong bean	3359	1233	20500	0.17
4. Okra	4085	1661	17950	0.25
5. Potato	4692	913	18000	0.27
6. Cucumber	5502	329	17900	0.31
7. Country bean	8638	455	24100	0.37
8. Teasle gourd	16460	1422	35400	0.48
9. White gourd	9524	455	17640	0.55
10. Pointed gourd	11292	2039	20850	0.60
11. Bitter gourd	14695	1451	24780	0.63

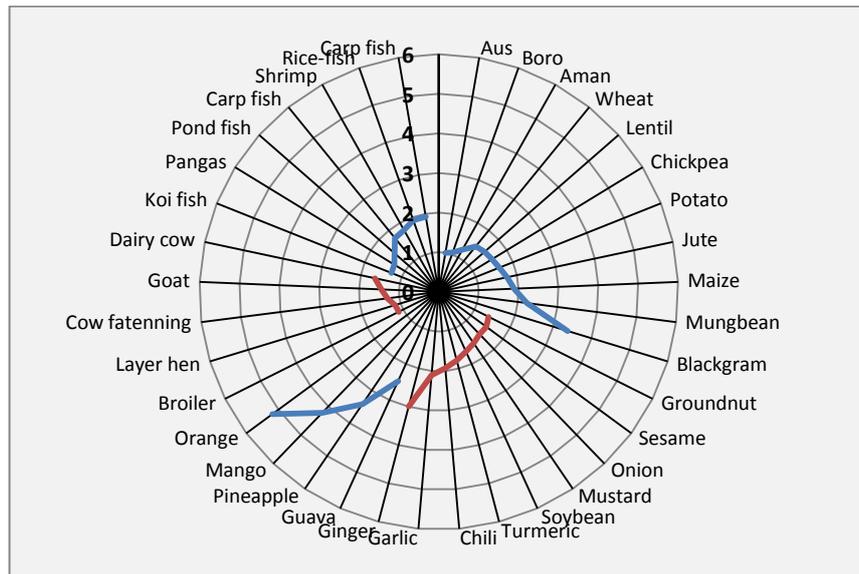
Source: Karim et al. 2011

4.13 Concluding Remarks

A basic tenet of this study is to test the profitability of farming various crops and non-crops enterprises, and understand their contribution to income of the farm household. Hence, it reviewed the existing status of financial and economic profitability of agricultural productions, agricultural incentives, and the comparative advantage of cultivating agricultural commodities by using scarce resources.

From the financial point of view, the existing literature indicates that the production of all crops and non-crop enterprises are profitable to the farmers since the benefit cost ratios (BCR) of all the commodity production are greater than unity. It also reveals that the profitability of most non-cereal crop production is higher than that of cereal production. The BCR wheel (Figure 1) clearly shows that in terms of profitability perennial fruit productions are the best followed by oilseed and spices, non-cereal crops, and fisheries. Livestock and poultry are among the least profitable agricultural commodities with BCR barely crossing one (so is rice). The productions of fruits and spice crops are more profitable compared to other crops and non-crop enterprises and this might be due to government subsidy on interest to farmers producing spices.

Figure 4.12 Profitability (BCR) radar of crops and non-crop agriculture



However, rice production is widespread in Bangladesh, which needs to be examined in order to understand the forces which might promote diversity in agriculture. At the same time, NGOs in Bangladesh have been promoting livestock and poultry farming to poor rural households (who do not have access to land for farming) where its benefit cost ratio also barely crossing unity. There were might be two reasons behind this promotional activity: i) livestock is considered as an asset to most poor households; ii) they can utilize their underutilized women and children through its rearing. There might other socio-economic reasons which are responsible for keeping our agriculture into rice, poultry, and livestock production. These issues need to be examined in order to understand the right policy handle to promote agricultural diversity.

From the economic point of view, the domestic market of rice, wheat, maize, potato, and lentil was not protected. Again, Bangladesh has comparative advantage in producing above commodities along with vegetables. Therefore, domestic production of these commodities may require substantial protection in future for import substitution and export promotion. Bangladesh can take initiative for rice export so that producers can harvest a share of export benefit in terms of higher price to some extent since it has attained self-sufficiency in rice production.

TREND AND GROWTH PERFORMANCE IN AGRICULTURE

In Bangladesh, the land area under agricultural production has been shrinking. The annual loss of agricultural land is 0.13% per annum due to construction of houses, roads and industrial infrastructure (Rahman and Hasan, 2003). Given this, there is little scope for expansion of agricultural land in Bangladesh. The alternative is intensification of agricultural production and/or vertical expansion of agriculture through investment and also adoption of technologies. There is ample scope for increasing the physical yields of particular crops and non-crop enterprises through changing cropping patterns and crop varieties. In this section, an attempt is made to analyze the trend and annual growth of area, production and yield of different crop and non-crop enterprises for 1990-2009 by regions of Bangladesh. Data were taken from different issues of Bangladesh Bureau of Statistics (BBS) for selected years.

5.1 Trends of Major Crops and Non-Crops Enterprises

In order to understand and to compare changes over time, a general index on area, production and yield has been presented in the tables below. At the same time since acreage, production and also yield varies between years, the study used an average in 5 years to measure trends and changes. Consequently, 1990-1995 averages are taken as the base year in the index and hence are equal to 100. Subsequent index values are measured based on this.

Cereal crops

Rice: The indices constructed for area, production and yield of rice for Bangladesh showed an increasing trend over the period from 1990 to 2009. In just 20 years time, from 1990 to 2009, total acreage went up to 69%, production increased by 140%, and yield increased 42% for the country. In terms of acreage, Dhaka, Chittagong and Sylhet divisions manifested a net fall while Rajshahi had the highest increase in rice acreage. The acreage increase is mainly due to expansion of cropping intensity. Yield increase is also significant in all divisions but there are differences between them too which is reflects both technological changes taking place in the rice agriculture as well as differences in suitability of land for rice cultivation (Table 5).

Table 5.1 Index of area, production and yield of rice crops

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	100 (2437692)	100 (4114112)	100 (6219832)	100 (3168043)	100 (3496853)	100 (2133824)	100 (3683137)	100 (25253493)
1995-1999	97	96	99	95	101	106	96	98
2000-2004	104	100	107	104	115	101	104	105
2005-2009	105	92	99	106	120	96	109	103
Production (mt)								
1990-1994	100 (1291896)	100 (3149820)	100 (4390888)	100 (2286037)	100 (2879079)	100 (1316327)	100 (2755517)	100 (18069564)
1995-1999	87	99	104	104	105	116	101	103
2000-2004	130	126	144	143	144	138	129	137
2005-2009	135	124	158	162	175	148	162	153
Yield (t/acre)								
1990-1994	100 (0.53)	100 (0.76)	100 (0.71)	100 (0.72)	100 (0.82)	100 (0.62)	100 (0.75)	100 (0.72)
1995-1999	90	103	105	109	104	109	105	104
2000-2004	125	125	135	137	124	137	124	130
2005-2009	129	135	159	153	145	154	148	148

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Wheat: The overall changes in the indices show that wheat area has drastically declined throughout the country over the past 20 years. Wheat is traditionally a competitor to maize in terms of land use. The decline generally reflects that as the profitability of maize has increased (shown in the previous chapter) there has been a gradual switch of land use from wheat to maize. The indices of production and yield of wheat significantly decreased over the period from 2005-2009 for all the divisions (Table 5.2). Yield decline is a puzzle. This needs to be understood clearly. With adoption of new technologies, wheat yield are expected to rise. It might be due to shifting of wheat cultivation to poor quality land as better land is shifted to maize cultivation. This hypothesis needs to be tested in our field survey.

Table 5.2 Index of area, production and yield of wheat

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (ac)								
1990-1994	100 (13090)	100 (125665)	100 (361686)	100 (235776)	100 (364200)	100 (18950)	100 (372668)	100 (1492036)
1995-1999	136	102	120	127	131	47	128	124
2000-2004	151	90	113	102	133	35	149	123
2005-2009	68	44	64	65	88	18	87	74
Production (mt)								
1990-1994	100 (7278)	100 (85662)	100 (242196)	100 (174726)	100 (260416)	100 (11366)	100 (271564)	100 (1053208)
1995-1999	172	133	141	156	154	54	150	148
2000-2004	194	100	126	126	169	49	186	150
2005-2009	83	38	65	68	102	21	90	79
Yield (t/ac)								
1990-1994	100 (0.56)	100 (0.7)	100 (0.67)	100 (0.74)	100 (0.71)	100 (0.6)	100 (1.45)	100 (0.71)
1995-1999	126	127	117	123	117	116	116	119
2000-2004	127	108	112	124	128	137	124	122
2005-2009	121	85	102	107	118	118	103	108

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Maize: In the case of maize, values of the indices generally fell in the first 10 year since 1990 but it rose dramatically in the next 10 years period. Such a very high increasing trend of area, production and yield of maize is generally attributed to the rapid expansion of maize production from a very low base. Also with increase in acreage improved seed became available to the farmers and hence a dramatic rise in yield is also observed. It shall be noted that unlike other crops, maize seeds are produced by maize farmers but are produced by designated 'seed growers' and so it is relatively easier to introduce improved variety of seed among maize growers (Table 5.3).

Table 5.3 Index of area, production and yield of maize

Time period	Chittagong	Dhaka	Khulna	Rajshahi	Rangpur	Bangladesh
Area (acre)						
1990-1994	100 (5644)	100 (454)	100 (112)	100 (891)	100 (327)	100 (7428)
1995-1999	79	50	216	54	213	83
2000-2004	112	1642	15150	1199	3392	713
2005-2009	264	5947	63435	7316	46100	4435
Production (mt)						
1990-1994	100 (2292)	100(182)	100(79)	100(272)	100(104)	100(2929)
1995-1999	80	61	206	64	252	87
2000-2004	136	5602	48652	6988	15967	2987
2005-2009	924	29148	199123	59281	381689	26993
Yield (t/acre)						
1990-1994	100 (0.41)	100 (0.42)	100 (0.69)	100 (0.3)	100 (0.63)	100 (0.39)
1995-1999	101	118	96	119	116	106
2000-2004	119	299	235	392	402	318
2005-2009	345	470	314	804	814	595

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Sugarcane: Area, production and yield indices of sugarcane showed a declining trend the past two decades. It is true in all divisions except Rajshahi, Sylhet and Chittagong where indices are mixed. In Sylhet are index increased initially and then fell but overall remain above the 1990 level, however, both production and yield declined. In Chittagong, area increased and then fell but production and yield showed a declining trend (Table 5.4). Sugarcane has been a cash crop for farmers for many years but it has now been replaced by other crops and so farmers are losing interest in production of sugarcane. At the same time, yield has been declining which means that without significant rise in yield rate (through research) it is heading towards a gradual decline.

Table 5.4 Index of area, production and yield of sugarcane

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	100 (9942)	100 (11689)	100 (115027)	100 (97844)	100 (138265)	100 (3967)	100 (79020)	100 (455754)
1995-1999	52	97	96	98	99	104	90	95
2000-2004	37	105	95	86	95	109	84	90
2005-2009	27	96	73	65	94	100	65	76
Production (mt)								
1990-1994	100 (120832)	100 (158014)	100 (1665009)	100 (1748354)	100 (2403417)	100 (32869)	100 (1305734)	100 (7434299)
1995-1999	48	92	93	110	97	101	96	98
2000-2004	27	89	94	97	93	106	76	90
2005-2009	12	70	63	62	104	43	63	75
Yield (t/acre)								
1990-1994	100 (12.21)	100 (13.58)	100 (14.54)	100 (17.87)	100 (17.38)	100 (8.27)	100 (33.95)	100 (16.31)
1995-1999	90	94	96	112	99	97	107	103
2000-2004	72	84	99	112	98	98	93	100
2005-2009	43	72	86	95	111	41	159	100

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Fruits: Fruits are high value crops to the farmers. A variety of seasonal and year-round fruits are produced in Bangladesh. Mango, jackfruit, pineapple, banana, guava, and jujube are the common and popular fruits in Bangladesh. Time series data from 1990 to 2009 were analyzed for constructing the indices of area, production and yield of different fruits³.

The overall area and production indices prepared for mango in Bangladesh represent an increasing trend over the period from 1995-1999 to 2005-2004. In mango production Rajshahi produces nearly one-third of the total production. Both Rajshahi and Khulna showed a dramatic rise in mango production while in Sylhet and also in Dhaka it has nearly doubled. Production fell dramatically in Barisal where mango farming is probably replaced by other cash crops (Table 5.5). Mango production received a boost with introduction of improved varieties in the last decade. Hence, the yield indices also show a dramatic rise in all the divisions except in Barisal and Sylhet during 200-2004.

Table 5.5 Index of area, production and yield of mango

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	100 (7078)	100 (16892)	100 (25321)	100 (12276)	100 (33379)	100 (8537)	100 (16830)	100 (120314)
1995-1999	103	105	104	103	100	112	100	103
2000-2004	103	107	105	104	102	111	92	103
Production (mt)								
1990-1994	100 (11998)	100 (19682)	100 (31096)	100 (15756)	100 (65629)	100 (14057)	100 (21774)	100 (179993)
1995-1999	82	104	103	107	108	108	95	103
2000-2004	98	118	114	115	123	111	107	115
Yield (t/acre)								
1990-1994	100 (1.69)	100 (1.16)	100 (1.23)	100 (1.28)	100 (1.96)	100 (1.76)	100 (2.61)	100 (1.5)
1995-1999	80	99	99	104	108	90	95	100
2000-2004	95	110	108	111	120	93	146	112

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

The overall indices constructed for Jackfruit area and production in Bangladesh also shows an increasing trend over the period from 1995 to 2004. The increasing trend of jackfruit production is much higher than that of area trend showing gains in yield. Similar trends for area and production were found among different divisions with slight exceptions (Table 5.6). Interestingly Barisal division shows a dramatic increase in production of jackfruit in the past two decades. The indices constructed for jackfruit yield show an overall decreasing trend throughout the country with slight exceptions found in Chittagong and Dhaka divisions.

³ For mango and jackfruit, data were used from 1990 to 2004 because BBS started changing their enumeration method for mango and jackfruit from 1995 which was highly inconvenient with previous data series.

Table 5.6 Index of area, production and yield of jackfruit

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	100 (2554)	100 (12972)	100 (17189)	100 (9419)	100 (6115)	100 (4539)	100 (8883)	100 (61672)
1995-1999	105	106	109	102	107	100	102	105
2000-2004	109	108	113	106	112	100	103	108
Production (mt)								
1990-1994	100 (3728)	100 (42988)	100 (82010)	100 (45709)	100 (20559)	100 (24684)	100 (35255)	100 (254934)
1995-1999	109	104	107	99	106	99	102	104
2000-2004	105	108	115	100	109	99	103	107
Yield (t/acre)								
1990-1994	100 (1.46)	100 (3.31)	100 (4.77)	100 (4.85)	100 (3.36)	100 (5.43)	100 (8.06)	100 (4.13)
1995-1999	103	98	98	97	99	99	100	98
2000-2004	96	100	101	95	98	99	99	99

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

The overall indices constructed for banana area, production, and yield in most of the divisions of Bangladesh showed an impressive increasing trend throughout the period of 1995 to 2009. The area, production and yield indices of banana for Barisal, Chittagong, and Sylhet division represent decreasing trend over the period (Table 5.7).

Table 5.7 Index of area production and yield of banana

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	100 (20340)	100 (25284)	100 (18293)	100 (11516)	100 (8669)	100 (2688)	100 (9615)	100 (96405)
1995-1999	96	102	105	106	105	90	99	101
2000-2004	99	106	125	141	126	73	115	114
2005-2009	83	95	247	232	133	51	110	141
Production (mt)								
1990-1994	100 (121505)	100 (211423)	100 (119889)	100 (58086)	100 (51085)	100 (17128)	100 (49792)	100 (628909)
1995-1999	95	93	100	106	104	97	100	97
2000-2004	83	71	116	181	135	71	121	101
2005-2009	54	60	275	384	162	28	144	144
Yield (t/acre)								
1990-1994	100 (5.97)	100 (8.36)	100 (6.55)	100 (5.04)	100 (5.89)	100 (6.37)	100 (10.29)	100 (6.52)
1995-1999	98	91	96	100	99	107	101	96
2000-2004	84	67	93	126	107	96	106	89
2005-2009	64	65	111	164	123	56	133	102

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

The overall indices constructed for pineapple area and production represent an increasing trend in Bangladesh throughout the period from 1995 to 2009. Similar increasing trends were found only in Dhaka division during the same period whereas production and acreage declined in all other divisions including Sylhet division which is the heartland of pineapple production. However, the yield indices showed an impressive increasing trend over the period in all the divisions except Barisal and Sylhet (Table 5.8). This productivity increase was mainly due to the introduction of improved pineapple variety along with other management technologies.

Table 5.8 Index of areaproductio n and yield of pineapple

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	100 (922)	100 (12003)	100 (10091)	100 (772)	100 (398)	100 (8908)	100 (974)	100 (34084)
1995-1999	89	96	107	107	76	101	93	100
2000-2004	92	102	127	101	72	95	96	107
2005-2009	62	82	243	58	52	60	74	122
Production (mt)								
1990-1994	100 (1878)	100 (48437)	100 (49432)	100 (1878)	100 (770)	100 (49058)	100 (1760)	100 (153307)
1995-1999	94	98	91	110	72	97	102	97
2000-2004	93	122	113	132	70	90	111	108
2005-2009	52	101	324	95	66	40	98	152
Yield (t/acre)								
1990-1994	100 (2.03)	100 (4.03)	100 (4.9)	100 (2.42)	100 (1.93)	100 (5.51)	100 (3.59)	100 (4.5)
1995-1999	106	102	86	103	95	96	112	96
2000-2004	101	119	87	135	98	96	118	101
2005-2009	84	123	133	164	128	61	130	125

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Vegetables: The overall indices constructed for area, production and yield of okra and cauliflower represented an impressive increasing trend over the period from 1990-1994 to 2005-2009 in Bangladesh which might be due to higher profitability of these two crops. Similar types of trends were found in all the divisions for these vegetables. Although the yield indices across the divisions represent a fluctuating trend over the period from 1995-1999 to 2000-2004, but increasing trends were prevailed during 2005-2009 (Table 5.9 and 5.10).

Table 5.9 Index of area, production and yield of okra

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	100 (607)	100 (2281)	100 (2595)	100 (1777)	100 (1176)	100 (421)	100 (1172)	100 (10029)
1995-1999	119	127	136	127	122	101	133	128
2000-2004	137	168	173	154	158	122	163	161
2005-2009	170	196	250	237	254	131	229	224
Production (mt)								
1990-1994	100 (691)	100 (3223)	100 (3018)	100 (2476)	100 (1426)	100 (467)	100 (1312)	100 (12613)
1995-1999	127	125	139	140	118	126	129	131
2000-2004	163	160	174	167	173	121	169	166
2005-2009	185	198	290	398	328	140	268	278
Yield (t/acre)								
1990-1994	100 (1.14)	100 (1.41)	100 (1.15)	100 (1.39)	100 (1.21)	100 (1.11)	100 (2.26)	100 (1.25)
1995-1999	107	98	103	110	96	123	93	103
2000-2004	119	95	101	108	108	99	100	103
2005-2009	109	101	115	166	128	167	115	124

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Table 5.10 Index of area, production and yield of cauliflower

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	100 (590)	100 (3280)	100 (5482)	100 (4703)	100 (3142)	100 (953)	100 (3397)	100 (21547)
1995-1999	115	121	121	101	90	113	114	115
2000-2004	129	141	129	119	104	124	129	129
2005-2009	174	186	166	163	154	171	172	174
Production (mt)								
1990-1994	100 (974)	100 (11427)	100 (16207)	100 (16161)	100 (8360)	100 (3114)	100 (11908)	100 (68184)
1995-1999	118	119	120	96	98	101	112	118
2000-2004	130	147	120	116	117	103	125	130
2005-2009	176	261	204	209	197	157	205	176
Yield (t/acre)								
1990-1994	100 (1.66)	100 (3.48)	100 (2.96)	100 (3.43)	100 (2.66)	100 (3.27)	100 (6.68)	100 (3.16)
1995-1999	103	97	99	94	109	91	98	103
2000-2004	101	103	92	96	113	86	97	101
2005-2009	102	139	123	128	127	95	119	102

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Indices of production, acreage and yield show that over the past two decades, brinjal production and area increased but increase in yield is not significant. Consequently, it is possible that increase in acreage is mainly driven by profitability led by price rise (Table 5.11).

Table 5.11 Index of area, production and yield of brinjal

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	100 (2599)	100 (11857)	100 (17796)	100 (13744)	100 (13769)	100 (2274)	100 (9530)	100 (71569)
1995-1999	129	133	141	123	98	145	143	128
2000-2004	227	321	239	160	123	282	252	217
2005-2009	158	212	197	173	124	155	154	172
Production (mt)								
1990-1994	100 (3920)	100 (34957)	100 (41383)	100 (37958)	100 (37105)	100 (6299)	100 (24341)	100 (185963)
1995-1999	128	117	144	138	97	118	129	125
2000-2004	228	270	232	161	117	265	229	202
2005-2009	193	180	224	223	128	115	139	181
Yield (t/acre)								
1990-1994	100 (1.51)	100 (2.94)	100 (2.32)	100 (2.75)	100 (2.69)	100 (2.77)	100 (2.55)	100 (2.6)
1995-1999	101	90	102	113	99	80	90	99
2000-2004	101	84	97	101	95	94	91	93
2005-2009	124	85	115	129	103	75	90	106

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

The indices for area, production and yield of bitter melon are shown in Table 5.12. The overall area and production indices represent an increasing trend, but productivity index showed a decreasing trend during the period from 1990-1994 to 2005-2009. Similar types of trends were found over the period mentioned above for all the divisions. The productivity indices showed

an increasing trend only for Rajshahi, Sylhet and Chittagong division over the above mentioned period. Again, there is no increase in yield in bitter gourd production over the past two decades indicating that increase in production and acreage is possibly driven by price rise.

Table 5.12 Index of area, production and yield of bitter gourd

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	100 (586)	100 (2319)	100 (3267)	100 (1686)	100 (2019)	100 (357)	100 (1948)	100 (12182)
1995-1999	93	118	114	115	99	100	108	110
2000-2004	106	141	126	131	98	115	97	119
2005-2009	163	170	167	198	149	124	147	164
Production (mt)								
1990-1994	100 (854)	100 (4145)	100 (4921)	100 (2478)	100 (3063)	100 (518)	100 (2895)	100 (18875)
1995-1999	82	126	109	116	102	81	110	110
2000-2004	105	149	110	118	105	90	107	118
2005-2009	144	176	153	316	211	111	174	190
Yield (t/acre)								
1990-1994	100 (1.45)	100 (1.79)	100 (1.5)	100 (1.47)	100 (1.52)	100 (1.44)	100 (2.9)	100 (1.55)
1995-1999	88	106	95	101	103	81	101	100
2000-2004	100	106	88	91	107	78	104	99
2005-2009	89	104	91	160	140	89	123	116

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

The overall indices of area, production and yield of pointed gourd (locally called *Potol*) represented an impressive increasing trend over the period considered for the study. But the indices of area, production and yield of pointed gourd constructed for different divisions represent fluctuating trend over the period (Table 5.13).

Table 5.13 Index of area, production and yield of pointed gourd

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	--	100 (147)	100 (1632)	100 (2528)	100 (3406)	--	100 (2219)	100 (9941)
1995-1999	--	117	149	121	133	--	133	132
2000-2004	--	167	211	113	160	--	263	179
2005-2009	--	64	193	344	200	--	197	233
Production (mt)								
1990-1994	--	100 (311)	100 (2674)	100 (4902)	100 (8088)	--	100 (4819)	100 (20805)
1995-1999	--	86	158	143	130	--	139	138
2000-2004	--	102	224	139	163	--	285	192
2005-2009	--	44	202	636	239	--	220	320
Yield (t/acre)								
1990-1994	--	100 (2.1)	100 (1.63)	100 (1.94)	100 (2.37)	--	100 (4.24)	100 (2.09)
1995-1999	--	81	106	118	98	--	102	104
2000-2004	--	62	107	122	102	--	104	107
2005-2009	--	69	105	185	119	--	111	138

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

The overall indices of area, production and yield of radish showed no significant change took place in production or acreage of radish production over the past two decades. At the same time, its yield per hectare declined in this period except in Khulna (Table 5.14).

The overall indices of area, production and yield of potato represented an exciting increasing trends over the period from 1990-1994 to 2000-2009 and this was true for all the divisions with slight exceptions found for area in Khulna and Sylhet (Table 5.15).

Table 5.14 Index of area, production and yield of radish

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	100 (3600)	100 (12029)	100 (12198)	100 (6281)	100 (7023)	100 (3539)	100 (5555)	100 (50225)
1995-1999	101	107	114	106	96	92	102	105
2000-2004	98	118	124	112	96	90	108	111
2005-2009	90	118	147	148	110	115	128	127
Production (mt)								
1990-1994	100 (10953)	100 (63692)	100 (45948)	100 (21025)	100 (24152)	100 (13841)	100 (17572)	100 (197183)
1995-1999	107	77	112	123	97	100	98	98
2000-2004	98	88	121	128	90	92	109	103
2005-2009	78	89	150	195	113	118	135	123
Yield (t/acre)								
1990-1994	100 (3.04)	100 (5.32)	100 (3.76)	100 (3.35)	100 (3.43)	100 (3.91)	100 (6.19)	100 (3.9)
1995-1999	106	72	99	116	101	108	94	93
2000-2004	100	74	97	114	93	103	100	92
2005-2009	87	75	102	132	102	102	106	97

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Table 5.15 Index of area, production and yield of potato

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	100 (3052)	100 (57608)	100 (92138)	100 (14692)	100 (76674)	100 (12682)	100 (54051)	100 (310897)
1995-1999	206	111	125	159	114	123	135	124
2000-2004	392	179	155	325	189	232	250	198
2005-2009	425	141	171	253	391	106	506	282
Production (mt)								
1990-1994	100 (10986)	100 (287244)	100 (501620)	100 (65503)	100 (224951)	100 (45190)	100 (165378)	100 (1300774)
1995-1999	222	115	141	193	118	115	150	135
2000-2004	466	213	206	490	235	234	382	253
2005-2009	736	169	255	375	677	119	939	402
Yield (t/acre)								
1990-1994	100 (3.59)	100 (4.99)	100 (5.35)	100 (4.43)	100 (2.93)	100 (3.56)	100 (6.13)	100 (4.17)
1995-1999	105	102	116	118	103	93	105	109
2000-2004	120	119	135	151	122	101	152	128
2005-2009	170	119	151	150	174	115	183	143

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Pulses: The overall indices constructed for major pulses area and production (i.e. lentil, mungbean and vetch (khesari, *Lathyrus cicera*) represent drastic declining trend over the period from 1995-1999 to 2005-2009 compared to base year of 1990-1994 with slight exception found in mungbean. The area and production trend scenarios were true for most of the divisions. Clearly, acreages under pulses are replaced with other cash crops.

Table 5.16 Index of area, production and yield of lentil

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	100 (16064)	100 (29988)	100 (158933)	100 (225103)	100 (72915)	100 (2247)	100 (10253)	100 (515503)
1995-1999	96	95	99	100	96	104	101	99
2000-2004	152	68	93	55	85	83	142	76
2005-2009	82	38	64	45	64	23	60	55
Production (mt)								
1990-1994	100 (4339)	100 (10949)	100 (51400)	100 (69294)	100 (20090)	100 (548)	100 (2505)	100 (159125)
1995-1999	81	89	101	115	97	122	108	105
2000-2004	136	55	88	62	84	101	157	76
2005-2009	70	30	64	57	73	27	67	60
Yield (t/acre)								
1990-1994	100 (0.27)	100 (0.37)	100 (0.32)	100 (0.31)	100 (0.28)	100 (0.24)	100 (0.52)	100 (0.31)
1995-1999	84	93	102	114	101	118	104	106
2000-2004	90	81	94	113	99	120	102	100
2005-2009	83	80	106	125	117	132	111	112

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Studies have listed a few causes for the decline in the pulse area. These are: i) most lentil areas were replaced by *Boro* rice, wheat, tobacco, mustard and cotton due to their high yield potential and better economic returns (Miah *et al.*, 1991); ii) pulse crops are highly susceptible to environmental stresses; and iii) the financial returns of these crops were not satisfactory to the farmers compared with other competing crops. Recent studies (Islam *et al.* 2010; Rahman *et al.* 2011) show that lentil is more profitable than *Boro* rice.

Table 5.17 Index of area, production and yield of mungbean

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	100 (80543)	100 (25025)	100 (14013)	100 (13298)	100 (820)	100 (75)	100 (4896)	100 (138670)
1995-1999	97	95	112	96	86	76	97	98
2000-2004	81	93	94	96	81	73	78	86
2005-2009	32	33	39	100	462	44	19	42
Production (mt)								
1990-1994	100 (15349)	100 (6697)	100 (3666)	100 (3902)	100 (203)	100 (20)	100 (1491)	100 (31329)
1995-1999	110	104	107	102	82	75	85	106
2000-2004	106	113	91	99	82	75	65	103
2005-2009	44	31	42	173	479	56	18	59

Table 5.17 continued

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Yield (t/acre)								
1990-1994	100 (0.19)	100 (0.26)	100 (0.26)	100 (0.29)	100 (0.24)	100 (0.26)	100 (0.61)	100 (0.23)
1995-1999	113	109	96	106	95	99	90	108
2000-2004	130	121	97	103	101	103	87	119
2005-2009	136	95	109	172	107	130	93	141

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Despite declining trend of area, productivity indices of mungbean and vetch in the past two decades an increasing trend in yield in some areas show that farmers producing these crops have adopted improved seeds and resorted to better farming techniques (Table 5.16, 5.17 & 5.18).

Table 5.18 Index of area, production and yield of vetch (khesari)

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	100 (208974)	100 (83813)	100 (188591)	100 (55058)	100 (47992)	100 (392)	100 (19266)	100 (604086)
1995-1999	88	100	103	97	77	102	88	94
2000-2004	70	84	77	87	63	74	58	75
2005-2009	44	35	41	79	50	26	16	44
Production (mt)								
1990-1994	100 (58604)	100 (24609)	100 (60148)	100 (16722)	100 (14076)	100 (124)	100 (7028)	100 (181311)
1995-1999	92	100	105	105	98	98	104	101
2000-2004	82	83	82	114	75	75	55	84
2005-2009	46	47	47	106	63	36	18	52
Yield (t/acre)								
1990-1994	100 (0.28)	100 (0.29)	100 (0.31)	100 (0.3)	100 (0.29)	100 (0.31)	100 (0.69)	100 (0.29)
1995-1999	106	100	102	109	129	97	114	106
2000-2004	117	99	107	132	119	102	97	112
2005-2009	102	130	116	134	126	138	107	117

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Oilseed (mustard): Mustard is one of the principal oilseed crops cultivated throughout the country. The overall indices of area and production show a decreasing trend over the period from 1990-1994 to 2005-2009. The length of mustard cultivation season the main reason for these declining trends. Mustard is mainly cultivated before *Boro* rice cultivation.

Table 5.19 Index of area, production and yield of mustard

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	100 (22207)	100 (130416)	100 (321123)	100 (133528)	100 (118579)	100 (19982)	100 (62914)	100 (808749)
1995-1999	97	97	101	109	103	95	106	102
2000-2004	85	99	80	116	99	95	89	93
2005-2009	38	23	77	78	96	33	57	68
Production (mt)								
1990-1994	100 (3864)	100 (38420)	100 (81801)	100 (39032)	100 (38241)	100 (5557)	100 (17437)	100 (224352)
1995-1999	100	84	112	118	115	108	116	109
2000-2004	89	96	91	132	100	119	108	102
2005-2009	41	28	99	102	125	42	74	88
Yield (t/acre)								
1990-1994	100 (0.17)	100 (0.29)	100 (0.25)	100 (0.29)	100 (0.32)	100 (0.27)	100 (0.55)	100 (0.28)
1995-1999	103	87	111	108	112	113	109	107
2000-2004	106	97	112	114	100	125	119	110
2005-2009	109	125	128	134	139	137	126	130

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Due to long duration of mustard farmers keep their land fallow for *Boro* rice. The oilseed Research Centre of BARI has already released two short duration HYV mustards namely BARIsarisa 14 and BARIsarisa 15 for farm level cultivation. Successful adoption of these varieties will obviously increase the area and production as well as farmers' income in the country. However, yield per hectare has gone up in this period mainly due to adoption of improved technologies (Table 5.19).

Spices: The overall indices prepared for the area, production and yield of selected spices namely onion, garlic, green chili, and turmeric represented an exciting increasing trend over the period from 1995-1999 to 2005-2009 with slight exception in the area of green chili. In the case of onion, the indices of area, production and yield showed increasing trends for Dhaka, Khulna and Rajshahi divisions and fluctuating trends were found in the rest of the divisions (Table 5.20).

In different divisions, impressive increasing trends were observed in the area and production of green chili over the period from 1995-1999 to 2000-2004 compared to the period of 2005-2009. On the other hand, the productivity index showed impressive increasing trend during the period from 2000-2004 to 2005-2009 for all the divisions (Table 5.21).

The indices of area, production and yield of turmeric showed increasing trends for Chittagong, Khulna and Sylhet division, whereas fluctuating trends were found in the rest of the divisions (Table 5.22).

Table 5.20 Index of area, production and yield of onion

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	100 (2012)	100 (5817)	100 (34062)	100 (12814)	100 (19625)	100 (1086)	100 (10155)	100 (85571)
1995-1999	95	94	96	105	94	113	108	98
2000-2004	86	78	107	135	123	106	106	112
2005-2009	94	88	280	384	559	45	166	326
Production (mt)								
1990-1994	100 (1868)	100 (7978)	100 (54353)	100 (24621)	100 (31156)	100 (1038)	100 (17619)	100 (138633)
1995-1999	107	103	99	99	99	132	100	100
2000-2004	80	84	118	136	141	150	90	121
2005-2009	100	125	438	665	1053	83	186	559
Yield (t/acre)								
1990-1994	100 (0.93)	100 (1.37)	100 (1.59)	100 (1.92)	100 (1.59)	100 (0.95)	100 (3.48)	100 (1.62)
1995-1999	112	109	104	94	106	117	92	101
2000-2004	94	107	108	98	110	142	85	105
2005-2009	108	142	158	172	188	182	110	172

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Table 5.21 Index of area, production and yield of green chili

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	100 (34170)	100 (49629)	100 (31562)	100 (4797)	100 (21780)	100 (3415)	100 (168493)	100 (183197)
1995-1999	126	117	144	139	112	139	129	105
2000-2004	254	204	320	270	137	309	250	198
2005-2009	157	153	221	250	113	209	183	138
Production (mt)								
1990-1994	100 (7939)	100 (16366)	100 (9136)	100 (2020)	100 (7871)	100 (1313)	100 (52089)	100 (47590)
1995-1999	126	123	144	132	121	165	135	131
2000-2004	267	209	342	271	149	392	267	251
2005-2009	202	244	310	671	174	355	278	256
Yield (t/acre)								
1990-1994	100 (0.23)	100 (0.33)	100 (0.29)	100 (0.42)	100 (0.36)	100 (0.38)	100 (0.31)	100 (0.28)
1995-1999	97	104	98	96	108	115	104	115
2000-2004	105	102	107	100	109	127	107	118
2005-2009	127	159	140	297	154	167	154	175

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Table 5.22 Index of area, production and yield of turmeric

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	100 (886)	100 (8378)	100 (7404)	100 (7014)	100 (8866)	100 (729)	100 (6059)	100 (39336)
1995-1999	100	103	103	105	94	124	96	101
2000-2004	93	117	111	107	85	132	92	103
2005-2009	104	161	145	154	109	104	108	134
Production (mt)								
1990-1994	100 (1026)	100 (9728)	100 (7330)	100 (8982)	100 (8169)	100 (677)	100 (6758)	100 (42670)
1995-1999	109	112	97	112	77	121	68	96
2000-2004	98	149	99	149	81	186	71	114
2005-2009	87	276	171	445	174	419	166	254
Yield (t/acre)								
1990-1994	100 (1.16)	100 (1.16)	100 (0.99)	100 (1.27)	100 (0.94)	100 (0.96)	100 (2.84)	100 (1.08)
1995-1999	109	109	95	108	80	95	61	95
2000-2004	106	126	89	136	94	140	68	110
2005-2009	94	171	117	287	155	392	131	188

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

The indices constructed for area and production of ginger shows an increasing trend over the past two decades for Dhaka, Khulna and Rajshahi divisions and while it shows a fluctuating trend for other divisions (Table 5.24). The table also revealed that the area and production drastically decreased during the period of 1995-1999 in Barisal Chittagong Sylhet and Rangpur divisions. In terms of yield rate also ginger is the worst performer.

Table 5.23 Index of area, production and yield of garlic

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	100 (1722)	100 (3085)	100 (12372)	100 (4640)	100 (4959)	100 (672)	100 (4068)	100 (31518)
1995-1999	91	110	98	108	99	120	107	102
2000-2004	105	102	107	116	168	125	120	119
2005-2009	131	115	161	212	717	59	174	249
Production (mt)								
1990-1994	100 (1547)	100 (3597)	100 (16310)	100 (5820)	100 (6223)	100 (670)	100 (4799)	100 (38966)
1995-1999	83	112	94	117	98	117	100	100
2000-2004	86	95	103	128	190	110	113	120
2005-2009	109	127	170	327	1096	65	219	339
Yield (t/acre)								
1990-1994	100 (0.9)	100 (1.17)	100 (1.32)	100 (1.25)	100 (1.25)	100 (0.99)	100 (2.36)	100 (1.24)
1995-1999	92	101	96	109	99	99	94	98
2000-2004	82	93	96	110	106	89	94	100
2005-2009	83	111	106	152	149	111	121	134

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Table 5.24 Index of area, production and yield of ginger

Time period	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (ac)								
1990-1994	100 (37)	100 (6034)	100 (3965)	100 (625)	100 (581)	100 (687)	100 (5429)	100 (17358)
1995-1999	78	98	107	109	108	79	92	98
2000-2004	124	114	125	120	115	68	85	106
2005-2009	24	169	137	107	124	47	104	133
Production (mt)								
1990-1994	100 (44)	100 (15978)	100 (8400)	100 (921)	100 (841)	100 (1338)	100 (14045)	100 (41568)
1995-1999	93	93	105	108	109	85	81	92
2000-2004	205	115	128	147	114	61	74	103
2005-2009	41	183	172	184	169	49	117	154
Yield (t/ac)								
1990-1994	100 (1.2)	100 (2.65)	100 (2.12)	100 (1.47)	100 (1.45)	100 (1.95)	100 (4.95)	100 (2.39)
1995-1999	123	95	99	99	101	108	86	94
2000-2004	165	101	102	123	99	89	89	97
2005-2009	--	119	125	172	137	108	134	118

Note: Figures within parentheses indicate 5 (five) year average value in the base year of the indices.

Figure 5.1 Changes in yields (t/ac) of selected spice crops over the years

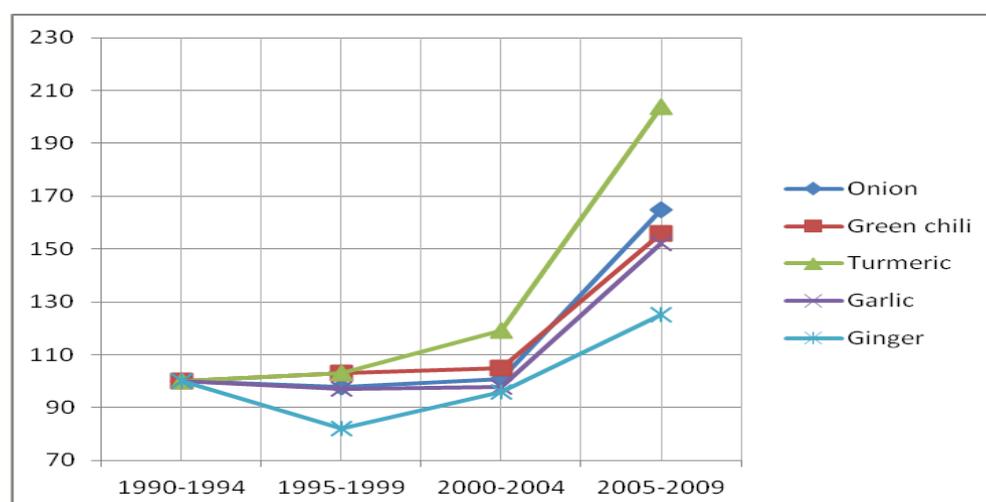


Figure 5.1 compares yield changes over the past two decades among the spice crops. It shows that turmeric is the best performer in terms of yield, while ginger the worst performer. Turmeric is followed by onion, green chili and garlic. However, it is also true that growth in productivity only occurred in the last decade.

5.2 Annual Growth Rates of Major Food Commodities by Region

In order to gain some perspective on the growth rates of area, production and yield of selected food commodities in Bangladesh, time series data from 1990 to 2009 were used for a growth analysis. The growth rates of major food commodities are discussed below.

Cereal crops: Among three rice crops, the highest growth was registered in the area, production and yield of *Boro* rice which might be due to both higher yield and access to irrigation compared to other rice crops where area expansion is difficult. Also, more varieties

are released for *Boro* rice than for other rice. The overall growth rates of the yield of three rice crops were positive for all the divisions of Bangladesh. The growth rate of area of Aman rice was negative for all divisions. In the case of *Aus* rice it was also negative except Barisal division (Table 5.25). Growth rate of area and production of *Aus* rice was found highest in Rajshahi division during the period of 2005-2009, while the growth rate of yield was found highest in Dhaka division (Appendix Table 33). The growth rate of area, production and yield of Aman rice was found positive and highest in Khulna, Rajshahi and Rangpur division respectively during the period of 2005-2009 (Appendix Table 34). Positive growth rate was registered for area, production and yield of *Boro* rice for most of the divisions during different time periods (Appendix Table 35).

Despite that fact that the area and production of wheat was declined during 1990-2009, the yield of wheat registered positive growth rate due to adoption of improved variety. The highest negative growth rate of area and production was found in Chittagong and Sylhet division respectively (Table 5.25). During 1995-1999 positive growth rate of area and production was registered for all the divisions except Sylhet. On the other hand, the highest number of positive growth rate of yield was found during 2005-2009 (Appendix Table 36).

Among the cereal crops the highest and the most impressive growth occurred in the production of maize both in terms of area, production and yield. The highest positive growth rate of area was registered for Khulna division, while the highest growth rate of production and yield was registered for Rangpur division during 1990-2009 (Table 5.25). The highest number of positive growth rates of area and production of maize were found during 2005-2009, while the highest positive growth rate of yield was found in Rajshahi division during 2000-04 (Appendix Table 37).

Table 5.25 Growth rates of area, production and yield of cereals and maize by division, 1990-2009

Crop	Barisal	Chittagong	Sylhet	Dhaka	Khulna	Rajshahi	Rangpur	Bangladesh
1. Aus rice								
Area	0.4 ^{ns}	-1.9***	-3.8***	-8.3***	-5.4***	-1.8*	-19.5***	-4.3***
Production	3.2***	0.2 ^{ns}	-1.9**	-6.1***	-2.8***	1.5 ^{ns}	-15.2***	-1.7***
Yield	2.8***	2.1***	2.0***	2.2***	2.5***	3.3***	4.3***	2.6***
2. Aman rice								
Area	-0.1 ^{ns}	-1.1***	-0.8**	-0.4 ^{ns}	-0.6***	-0.2 ^{ns}	-0.4 ^{ns}	-0.5***
Production	1.0 ^{ns}	0.3 ^{ns}	1.5***	1.8***	1.3***	1.4***	0.7 ^{ns}	1.1***
Yield	1.2*	1.4***	2.3***	2.1***	1.9***	1.6***	1.1***	1.6***
3. Boro rice								
Area	5.1***	1.5***	1.6***	3.3***	6.7***	4.1***	6.4***	3.8***
Production	7.3***	3.6***	5.2***	5.3***	8.8***	6.3***	8.5***	6.0***
Yield	2.3***	2.2***	3.7***	2.0***	2.1***	2.1***	2.0***	2.3***
4. Wheat								
Area	-2.2 ^{ns}	-5.4***	-1.9***	-2.8***	-3.0***	-0.7 ^{ns}	-0.6 ^{ns}	-1.9**
Production	-0.7 ^{ns}	-6.5***	-9.5***	-2.5*	-2.3*	0.5 ^{ns}	-0.2 ^{ns}	-1.2 ^{ns}
Yield	1.4**	-1.1 ^{ns}	1.4**	0.3 ^{ns}	0.7 ^{ns}	1.3***	0.3 ^{ns}	0.7 ^{ns}
5. Maize								
Area	38.4***	6.4***	--	30.4***	44.0***	29.7***	40.6***	25.5***
Production	45.4***	13.8***	--	41.1***	52.4***	43.9***	55.1***	37.9***
Yield	7.0**	7.5**	--	10.7***	8.4***	14.2***	14.5***	12.5***

Note: Area in acre, production in metric ton and yield in ton per acre

‘***’, ‘**’ and ‘*’ indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

Sources of cereal production growth: The sources of change in average cereal production in different regions of Bangladesh are shown in Table 5.26. Changes in mean Aus area appeared to be the largest responsible factor for decrease in mean production in all the regions except Barisal and Rajshahi divisions. In Barisal and Rajshahi divisions, changes in mean area and yield influenced negatively and positively to a large extent to increase Aus production respectively. This means that the reduction of mean area decreased production, but increase in mean yield contributed to maintain production level. At the national level, the sources of change in average Aman production was the change in mean yield in Bangladesh. This pattern was observed in all the regions of Bangladesh. In the case of Boro rice, changes in both mean area and mean yield appeared to be the source of change in mean production in all the regions of Bangladesh.

Table 5.26 Growth decomposition in cereals and maize production in Bangladesh, 1990-2009 (%)

Crop	Effect	Divisions							Bangladesh
		Baris	Chittagong	Sylhet	Dhaka	Khulna	Rajshah	Rangpu	
Aus	Yield	96	-333	-144	-31	-201	67	-14	-147
	Area	9	413	196	126	322	32	116	240
	Interaction	5	-20	-49	-4	20	-1	2	-8
	Residual	-10	40	97	9	-41	2	-4	15
Aman	Yield	104	244	116	108	104	92	278	116
	Area	13	-122	-11	12	0	4	-57	-5
	Interaction	17	23	6	21	3	-4	15	12
	Residual	-34	-45	-11	-41	-7	8	-136	-23
Boro	Yield	27	60	65	21	17	45	63	37
	Area	78	46	40	76	76	57	141	66
	Interaction	4	7	6	-3	-7	2	3	2
	Residual	-9	-13	-11	6	14	-4	-107	-5
Wheat	Yield	-462	-8	-58	-308	1937	136	5	-769
	Area	548	117	142	364	-1596	-22	223	793
	Interaction	-14	9	-15	-45	240	14	-13	-76
	Residual	28	-18	31	89	-481	-27	-115	152
Maize	Yield	14	65	0	20	52	-54	33	20
	Area	120	44	0	100	123	122	196	96
	Interaction	35	9	0	20	75	-32	27	15
	Residual	-68	-18	0	-40	-150	64	-156	-31

Source: Author's calculation using time series data from various issues of BBS

Table 5.26 further reveals that change in mean area was the most important source of change in average wheat production at national level. On the other hand, change in mean area was the important source of change in mean wheat production in all the divisions except Rajshahi and Khulna divisions. In the case of maize, change in both mean area and yield were the important sources of change in mean production at national level. Similar observations were observed in all the divisions except Rajshahi division.

Sugarcane: The overall growth rates in terms of area, production and yield of sugarcane were negative during 1990-2009 and it was true for all divisions except Chittagong and Sylhet where it was slightly positive, and in Rajshahi only in terms of yield (Table 5.27). Sugarcane is a cash intensive and long-duration crop. Therefore, most of the farmers show negative attitude towards its cultivation which might have caused the decline. The overall growth rates of area, production and yield of sugarcane were found negative during different periods except the growth rate of yield in 2005-2009. Significant positive growth rate of area was found in Sylhet

division during 1990-1994. Similarly, significant positive growth rates of production and yield were found in Sylhet division during 1990-1994 and 1995-1999 respectively (Appendix Table 38).

Table 5.27 Average annual growth rates of area, production and yield of sugarcane by division, 1990-2009

Division	Area (acre)	Production (mt)	Yield (t/acre)
Barisal	-9.4***	-14.3***	-4.9***
Chittagong	0.1 ^{ns}	-2.3***	-2.4***
Dhaka	-1.7***	-2.5***	-0.8**
Khulna	-2.5***	-2.8*	-0.3 ^{ns}
Rajshahi	-0.4 ^{ns}	-0.2 ^{ns}	0.2 ^{ns}
Sylhet	0.3 ^{ns}	-4.8**	-5.1***
Rangpur	-1.9***	-3.1***	-1.1**
Bangladesh	-1.9***	-2.0***	-0.2***

Note: '***', '**' and '*' indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

Sources of sugarcane production growth: The change in mean area was the principal contributor to change in mean production of sugarcane in Bangladesh. It contributed about 124% of the change to mean production. Similar contributions were observed in all the divisions except Sylhet and Rajshahi divisions (Table 5.28).

Table 5.28 Growth decomposition in production of sugarcane in Bangladesh, 1990-2009 (%)

Crop	Effect	Division							Bangladesh
		Barisal	Chittagong	Sylhet	Dhaka	Khulna	Rajshahi	Rangpur	
Sugar cane	Yield	14	48	107	62	8	332	-435	-18
	Area	85	80	-19	36	91	-205	1212	124
	Interaction	-1	28	-12	-2	0	27	811	7
	Residual	2	-56	24	4	1	-54	-1488	-13

Source: Author's calculation using time series data from various issues of BBS

Vegetables: Most vegetables are considered as high value crops in Bangladesh. A plenty of vegetables are exported every year to UK, Europe and Middle East countries for ethnic people. Again, vegetable cultivation is highly profitable to the farmers compared to many other crops. Table 5.29 reveals that the area, production and yield of major vegetables namely potato, brinjal, cauliflower, cabbage, radish, okra, bitter gourd and pointed gourd registered highly positive growth rates during 1990-2009.

The overall growth rates of area, production and yield of Potato was found higher in Rangpur division. The highest growth rate of area and production was found in Barisal division during 1995-1999, while the growth rate of yield was highest in Dhaka division during 1990-1994 (Appendix Table 39).

Barisal and Khulna divisions registered the highest number of positive growth rates for brinjal during different time periods. The highest positive and significant growth rate of area and production were found in Chittagong and Dhaka divisions. Details growth rates for different periods can be shown in (Appendix Table 40).

The overall positive and significant growth rate of area and production of cabbage was found during all the time periods. The overall negative growth rate of yield was registered during 1990-1994 and 1995-1999. Over the different time periods maximum numbers of positive growth rates were found in Chittagong division followed by Dhaka (Appendix Table 41).

The overall highest positive and significant growth of radish area was found during 2000-2004 and the highest growth rate of production and yield was found during 2005-2009. Rangpur division registered the highest growth rate of area and production during 2005-2009. Khulna division registered the higher growth rate of area, production and yield compared to other divisions (Appendix Table 42).

The area of okra registered negative growth rate in Sylhet and Rangpur division during 1990-1994. Similarly, the negative growth rates of production were observed at Chittagong, Sylhet and Rangpur division during 2005-09, 2000-2004 and 1990-1994 respectively (Appendix Table 43).

The overall growth rate of area, production and yield of bitter gourd was found positive and significant during different time periods. The overall higher positive and significant growth rate of area and production was found in Khulna division compared to other divisions. The highest positive growth rate of production and yield was found in Sylhet division during 2005-2009 (Appendix Table 44).

Table 5.29 Growth rates of area, production and yield of major vegetables by division, 1990-2009

Crop	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
1. Potato								
Area	10.1***	3.1***	3.7***	7.3***	9.0***	1.5 ^{ns}	10.8***	7.1***
Production	13.5***	4.4***	6.6***	10.1***	12.5***	2.5 ^{ns}	15.1***	9.5***
Yield	3.5***	1.3***	2.9***	2.8***	3.5***	1.0**	4.3***	2.4***
2. Brinjal								
Area	3.5**	6.2***	5.2***	3.8***	1.7***	3.6**	3.8***	4.3***
Production	4.8***	5.0**	5.9***	5.1***	1.9***	2.2 ^{ns}	3.3**	4.6***
Yield	1.3***	-1.1***	0.7**	1.4***	0.2 ^{ns}	-1.4**	-0.5**	0.3 ^{ns}
3. Cauliflower								
Area	3.5***	3.4***	4.0***	3.2***	3.2***	2.9***	3.3***	3.5***
Production	5.7***	3.5***	6.1***	4.3***	4.8***	4.1***	2.7***	4.5***
Yield	2.2***	0.1 ^{ns}	2.1***	1.1**	1.5***	1.2**	-0.4 ^{ns}	1.0***
4. Cabbage								
Area	3.9***	3.3***	5.1***	3.4***	3.0***	2.6***	3.6***	3.7***
Production	3.7***	5.0***	7.7***	5.5***	5.5***	3.2***	4.9***	5.8***
Yield	-0.3 ^{ns}	1.7***	2.6***	2.2***	2.5***	0.6 ^{ns}	1.3***	1.0***
5. Radish								
Area	-2.0**	-0.1 ^{ns}	1.7***	2.2***	0.1 ^{ns}	-0.5 ^{ns}	1.3***	1.5***
Production	-3.2***	-0.9 ^{ns}	1.8***	3.7***	0.1 ^{ns}	-0.9 ^{ns}	1.8***	1.5***
Yield	-1.2**	-0.8 ^{ns}	0.1 ^{ns}	1.5***	0.0 ^{ns}	-0.4 ^{ns}	0.6 ^{ns}	0.0***
6. Okra								
Area	3.4***	4.6***	6.0***	5.5***	6.0***	0.9 ^{ns}	5.3***	5.3***
Production	4.1***	4.6***	6.8***	8.4***	7.8***	1.7 ^{ns}	6.3***	6.6***
Yield	0.7**	0.0 ^{ns}	0.9**	2.9***	1.8***	0.8 ^{ns}	1.0***	1.3***
7. Bittergourd								
Area	2.7***	3.6***	3.1***	4.2***	2.0**	1.3***	1.8***	3.1***
Production	2.3***	4.0***	2.2***	6.4***	3.8***	0.3 ^{ns}	2.7***	3.9***
Yield	-0.4 ^{ns}	0.4**	-1.0*	2.2 ^{ns}	1.8 ^{ns}	-1.1 ^{ns}	1.1 ^{ns}	0.8***
8. Pointed gourd								
Area	--	-1.6 ^{ns}	4.7***	7.0***	4.7***	--	5.4***	5.7***
Production	--	-4.3**	5.0***	10.6***	5.8***	--	6.2***	7.6***
Yield	--	-2.7***	0.3*	3.6***	1.1***	--	0.7***	1.9***

Note: Area in acre, production in metric ton and yield in ton per acre

‘***’, ‘**’ and ‘*’ indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

The higher positive and significant growth rate of area, production and yield of pointed gourd was found in Khulna division compared to other divisions. The highest negative growth rate of area, production and yield was found in Chittagong division during 2000-2004 and 1995-1999 respectively. Again, the highest positive growth rate of area, production and yield was found in Rangpur division during 1995-1999 and 2005-2009 respectively (Appendix Table 45).

Sources of vegetable production growth: The changes in both mean area and yield were the important sources of change in mean production of all vegetables at national level. But the effect of change in mean area was much higher compared to the effect of change in mean yield except for pointed gourd production at national level. Similar sources of changes were observed in the mean production of cauliflower and bitter gourd for all divisions. The sources of changes in the mean productions of other vegetables were found to be more or less same with slight exceptions in Barisal and Sylhet for potato, brinjal and pointed gourd production (Table 5.30).

Table 5.30 Growth decomposition in production of vegetables in Bangladesh, 1990-2009 (%)

Crop	Effect	Division							Bangla desh
		Barisal	Chittagong	Sylhet	Dhaka	Khulna	Rajshahi	Rangpur	
Potato	Yield	66	52	292	51	28	11	21	15
	Area	46	75	-231	51	86	98	214	91
	Interaction	12	28	-38	1	13	9	38	5
	Residual	-24	-55	77	-3	-27	-18	-173	-11
Brinjal	Yield	194	-93	197	28	46	41	11	25
	Area	-159	153	-635	66	53	55	109	63
	Interaction	-65	-40	-538	-6	-1	-4	20	-12
	Residual	130	80	1076	12	2	8	-40	24
Cauli- flower	Yield	35	3	-76	45	27	49	0	29
	Area	71	89	181	58	76	56	212	74
	Interaction	6	-8	5	4	2	5	6	2
	Residual	-12	16	-10	-7	-5	-10	-118	-5
Cabbage	Yield	-2	33	22	47	35	67	64	39
	Area	105	69	81	58	66	35	148	64
	Interaction	3	1	2	5	1	1	10	3
	Residual	-6	-3	-5	-10	-2	-3	-122	-6
Radish	Yield	31	52	-41	28	35	46	53	35
	Area	65	31	139	74	69	57	163	66
	Interaction	-4	-17	-1	2	4	4	5	0
	Residual	8	34	3	-4	-8	-7	-121	-1
Okra	Yield	-14	0	85	23	47	30	9	30
	Area	112	102	-571	82	58	75	204	72
	Interaction	-2	0	-587	5	4	4	15	2
	Residual	4	-2	1173	-10	-9	-8	-128	-4
Bitter gourd	Yield	-14	-36	-111	24	61	47	76	26
	Area	112	141	216	78	69	58	132	76
	Interaction	-1	5	6	2	32	5	0	3
	Residual	3	-11	-11	-4	-62	-10	-108	-5
Pointed gourd	Yield	139		13	36	19	62	32	139
	Area	62		89	85	78	124	71	62
	Interaction	100		2	21	-3	1	3	100
	Residual	-201		-4	-42	6	-87	-6	-201

Fruits: Based on available information, four major fruits have been considered for growth rate analysis. The highest growth rate registered in the area of banana followed by pineapple, whereas it was highest for mango followed by pineapple. The highest growth rate of yield was found for mango and negative growth rate was for Banana. The overall growth performance regarding the area, production and yield of banana was found better in Khulna division, mango in Rajshahi division, pineapple and jackfruit in Dhaka division (Table 5.31).

The maximum numbers of positive and significant growth rates of banana area were found in Dhaka and Khulna division. The highest positive and significant growth rate of area and production of banana was found in Khulna division during 2000-2004. Productivity growth rate was found highest in Rangpur division during 2005-2009. Barisal and Chittagong division registered negative growth rate of the production and yield of banana during different time periods (Appendix Table 46).

The overall positive and significant growth rate of pineapple area was found in Dhaka division. Dhaka division registered the highest positive growth rate during 2005-2009. Rajshahi and Sylhet division registered maximum number of negative production growth rate during different time periods. Positive and significant growth rate of pineapple yield was found in Khulna, Rajshahi and Sylhet division during 2000-2004 (Appendix Table 47).

Table 5.31 Growth rates of area, production and yield of fruits by division, 1990-2009

Crop	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
1. Banana								
Area	-1.1***	-0.2 ^{ns}	5.5***	5.5***	1.9***	-4.6***	0.9***	2.2***
Production	-4.4***	-3.6***	6.0***	8.9***	3.4***	-9.4***	2.5***	2.1***
Yield	-3.3***	-3.4***	0.5*	3.4***	1.5***	-4.9***	1.8***	-0.1 ^{ns}
2. Pineapple								
Area	-2.8***	-1.1***	5.5***	-3.4***	-4.2***	-4.3***	-1.8***	1.2***
Production	-3.8***	0.5 ^{ns}	7.1***	-0.1 ^{ns}	-2.7***	-7.8***	-0.1 ^{ns}	2.6***
Yield	-1.1**	1.6***	1.6**	3.3***	1.5***	-3.5***	1.7***	1.4***
3. Mango								
Area	0.3***	0.7***	0.5***	0.3***	0.2 ^{ns}	1.6 ^{ns}	-0.6 ^{ns}	0.3**
Production	-0.4 ^{ns}	1.7**	1.3**	1.5***	2.1***	1.3**	0.7 ^{ns}	1.5**
Yield	-0.7 ^{ns}	1 ^{ns}	0.8*	1.2***	1.9***	-0.3 ^{ns}	1.8 ^{ns}	-1.2**
4. Jackfruit								
Area	0.9***	0.7***	1.2***	0.6***	1.1***	0.1 ^{ns}	0.3***	0.8***
Production	0.5*	0.7***	1.4***	0.1***	0.9***	-0.1 ^{ns}	0.3***	0.7***
Yield	-0.4 ^{ns}	0.0 ^{ns}	0.2 ^{ns}	-0.5***	0.2***	-0.2**	0 ^{ns}	-0.1 ^{ns}

Note: Area in acre, production in metric ton and yield in ton per acre

‘***’, ‘**’ and ‘*’ indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

Growth rates of mango and jackfruit were calculated using data from 1990 to 2004 due to lack of consistent data of 2005-2009

The positive and significant growth rate of mango area was found in Chittagong division during different time periods. All the divisions except Rangpur registered positive growth rate of mango area during 1990-1994. The positive and significant growth rate of production and yield was found in all the regions except Rangpur division during 2000-2004 (Appendix Table 48).

Most of the divisions registered positive growth rate for jackfruit area and production during different time periods. Rajshahi division registered the highest growth rate of area during 2000-

2004. Sylhet division registered negative growth rate of production and yield during different time periods. Among all the divisions no positive and significant yield growth rate was found in different time periods (Appendix Table 49).

Sources of fruit production growth: The important source of changes in mean productions of pineapple, mango and jackfruit was the change in mean yield and the change of mean area was for change in production of banana at national level. More or less similar sources of changes were observed in all the divisions except Barisal for mango and jackfruit production. On the other side, the change in mean area was the main contributor of changing the mean production of banana and pineapple in all the divisions except Chittagong for pineapple production, and Barisal, Chittagong and Rajshahi for banana production (Table 5.32).

Table 5.32 Growth decomposition in production of fruits in Bangladesh, 1990-2009 (%)

Crop	Effect	Division							Bangla desh
		Barisal	Chittagong	Sylhet	Dhaka	Khulna	Rajshahi	Rangpur	
Banana	Yield	70	117	41	26	41	94	142	-2
	Area	27	18	71	88	73	-4	55	110
	Interaction	-3	35	13	15	14	-10	4	8
	Residual	6	-70	-25	-29	-28	20	-100	-16
Pineapple	Yield	-25	145059	59	35	-125	-63	-100	72
	Area	105	-128186	51	74	276	161	319	32
	Interaction	-20	16773	10	8	52	-2	-9	3
	Residual	40	-33546	-20	-17	-103	4	-110	-7
Mango	Yield	-189	105	187	174	212	59	129	101
	Area	-777	-1898	-1382	-497	-154	42	-2829	-85
	Interaction	-1066	-1893	-1295	-423	-42	1	-2924	-84
	Residual	2132	3786	2590	846	84	-2	5724	168
Jackfruit	Yield		116	-731	116	105	84	218	74
	Area		-481	-2090	-877	-166	-714	-1395	-588
	Interaction		-466	-2922	-861	-161	-730	-1344	-614
	Residual		931	5843	1722	322	1460	2621	1228

Note: Growth decomposition in production on mango and jackfruit is calculated for the period from 1990 to 2004

Pulses: It includes different types of pulses including lentil, mungbean, vetch, and chickpea. Despite the adoption of improved technology of pulses, the area and production registered negative growth rates during 1990-2009 in Bangladesh. The negative growth rates of area and production are also observed in most of the divisions (Table 5.33). Pulse producers faced an uphill battle in terms of profitability over the same period and as such its land coverage continuously fell. Moreover, some of these crops are susceptible to environmental stress and so increased risk of production which further contributed to this fall in acreage (Miah et al. 2009).

The growth rates of lentil area for different periods show that positive and significant growths registered at Barisal, Khulna and Sylhet division during 1990-1994. Positive and significant production growth rate was found at Khulna and Rangpur division during 1990-1994 and 1995-1999 respectively. The maximum number of positive growth rate of yield was found in Rajshahi division (Appendix Table 50).

In case of mungbean, most of the divisions registered negative and significant growth rates in area and production, while the negative and significant growth rate of yield was found only in Rangpur division. The maximum numbers of negative growth rates of area and production was found at Dhaka division over the different time periods. The highest positive growth rate of mungbean yield was found in Sylhet division during 2005-2009 (Appendix Table 51).

During 1990-1994, most of the divisions except Dhaka and Rangpur registered positive growth rate of area and production of vetch. Overall yield growth rate was found positive for all the divisions. The highest negative growth rate of area and production was found in Barisal division during 2005-2009 (Appendix Table 52).

The highest negative and significant growth rate of area and production of chickpea was found in Khulna division during 2005-2009. Again, the highest positive and significant growth rate was found in Rangpur division during 2000-2004. The overall growth rates of yield were found positive and significant in all the divisions except Dhaka (Appendix Table 53).

Table 5.33 Growth rates of area, production and yield of major pulses by division, 1990-2009

Crop	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
1. Lentil								
Area	-0.9 ^{ns}	-7.3***	-3.4***	-6.0***	-3.6***	-13.3***	-3.1**	-4.6***
Production	-2.8 ^{ns}	-8.9***	-3.3***	-4.7***	-2.6***	-11.6***	-2.1 ^{ns}	-4.0***
Yield	-0.9**	-1.6***	0.1 ^{ns}	1.3***	1.0***	1.7***	0.7**	0.6**
2. Mungbean								
Area	-6.9***	-6.4***	-6.4***	0.0 ^{ns}	8.0***	-5.3***	-10.3***	-5.3***
Production	-4.8***	-6.5***	-5.9***	3.1***	8.6***	-3.5***	-11.1***	-3.1***
Yield	2.1***	-0.1 ^{ns}	0.6*	3.1***	0.6 ^{ns}	1.8***	-0.5**	4.9**
3. Vetch								
Area	-6.3***	-6.8***	-6.0***	-1.6**	-4.6***	-8.0***	-12.1***	-5.5***
Production	-6.0***	-5.6***	-5.0***	0.4 ^{ns}	-3.2***	-6.0***	-11.2***	-4.5***
Yield	0.3 ^{ns}	1.2*	1.0***	2.0***	1.4***	2.0***	0.4 ^{ns}	1.1***
4. Chickpea								
Area	-8.6***	-6.1***	-16.6***	-16.6***	-13.1***	--	-14.6***	-15.1***
Production	-7.9***	-5.2***	-17.5***	-16.2***	-12.4***	--	-13.8***	-15.1***
Yield	0.7*	0.9***	-0.9 ^{ns}	0.4**	0.7*	--	0.6**	0.0***

Note: Area in acre, production in metric ton and yield in ton per acre

'***', '**' and '*' indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

Sources of pulses production growth: Table 5.34 shows that the important source of changes in mean productions of pulses was due to change in mean pulse area at national level. On the other side, the change in mean yield of pulses contributed negatively to total change in mean production of pulses at national level.

In the case of lentil, the changes in both mean yield and area contributed positively to total change in production in Barisal, Chittagong, and Dhaka divisions. The change in mean area positively contributed to the change in mean production of mungbean in all regions except Sylhet division. Again, the important source of changes in mean productions of chickpea and vetch was the change in mean area in all the divisions, except Sylhet and Khulna division respectively.

Table 5.34 Growth decomposition in production of pulses in Bangladesh, 1990-2009 (%)

Crop	Effect	Division							Bangladesh
		Barisal	Chittagong	Sylhet	Dhaka	Khulna	Rajshahi	Rangpur	
Lentil	Yield	12	23	-42	22	-78	-45	-16	-18
	Area	76	79	142	114	164	157	249	128
	Interaction	-11	2	1	35	-13	12	20	10
	Residual	23	-4	-1	-71	27	-24	-153	-20
Mung bean	Yield	-63	-19		-10	74	35	33	-90
	Area	183	97		112	25	16	166	201
	Interaction	20	-22		2	-1	-49	5	11
	Residual	-40	44		-4	2	98	-104	-22
Chick pea	Yield	-9	-17	-58	97	-18	-3	10	-32
	Area	110	123	-125	348	120	111	199	125
	Interaction	2	6	-283	345	3	9	5	-7
	Residual	-3	-11	566	-690	-5	-17	-114	14
Vetch	Yield	-27	-34	-64	-22	8462	-57	-26	-39
	Area	115	177	134	123	-7470	164	206	139
	Interaction	-12	45	-30	0	893	8	-9	0
	Residual	24	-88	60	-1	-1785	-15	-71	0

Oilseed: The area under and production of mustard and groundnut had negative growth rates during the period of 1990-2009. However, the productivity per hectare showed positive growths which is due to adoption of improved technologies. These observations are true for the productivity growth of mustard of all the divisions. But there are some exceptions found in Rajshahi and Rangpur division in the case of groundnut yield (Table 5.35).

The area and production of mustard registered negative and significant growth rate of during the last decade in almost all the divisions. The growth rate of yield was found positive and significant for most of the divisions during the same period of time. The highest positive growth rate of yield was registered in Rajshahi division during 2005-2009 (Appendix Table 54).

The overall groundnut production registered positive and significant growth rate during the period of 2005-09. The highest positive growth rate of area of groundnut was found in Rangpur division during 2005-09. The growth rates of production estimated for other periods were negative. The highest positive and significant growth rates of yield were observed in Barisal division during 2005-09 followed by Khulna division during 2000-04 (Appendix Table 55).

Table 5.35 Growth rates of area, production and yield of major oilseeds by division, 1990-2009

Crop	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
1. Mustard								
Area	-8.0***	-8.6***	-1.9***	-1.6*	-0.6 ^{ns}	-8.1***	-3.7***	-2.5***
Production	-7.3***	-7.1***	-0.4 ^{ns}	0.3 ^{ns}	1.1*	-6.0***	-2.0**	-0.8**
Yield	0.6***	1.5***	1.5***	1.8***	1.6**	2.1***	1.6***	1.7***
2. Groundnut								
Area	-2.3***	-3.1***	-1.4***	4.4**	2.6***	-1.4***	-3.2 ^{ns}	-1.6***
Production	-0.8 ^{ns}	-0.4 ^{ns}	-0.6 ^{ns}	8.0***	1.1 ^{ns}	0.8 ^{ns}	-2.1 ^{ns}	0.01 ^{ns}
Yield	1.4*	2.7***	0.8 ^{ns}	3.6***	-1.5***	2.2***	-0.3 ^{ns}	1.6***

Note: Area in acre, production in metric ton and yield in ton per acre

‘***’, ‘**’ and ‘*’ indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

Sources of oilseed production growth: Change in mean area appeared to be the largest source of change in mean production of mustard in all that divisions except Dhaka and Rajshahi. At national level, it contributed 750% of the changes in mean production of mustard. This means that the change has come through the expansion of area under mustard production. The opposite scenarios can be observed in the case of groundnut production at national level. It means that the major change in mean production of groundnut has come through the change in mean yield at national level. Change in mean area appeared to be the largest source of change in mean production of groundnut in Barisal, Dhaka, Khulna, Rajshahi and Rangpur divisions (Table 5.36).

Table 5.36 Growth decomposition in production of oilseeds in Bangladesh, 1990-2009 (%)

Crop	Effect	Division							Bangladesh
		Barisal	Chittagong	Sylhet	Dhaka	Khulna	Rajshahi	Rangpur	
Mustard	Yield	-36	-14	-40	166	-230	206	-217	-612
	Area	122	129	147	-62	360	-234	414	750
	Interaction	-14	15	7	4	29	-128	-7	37
	Residual	28	-30	-15	-8	-59	256	-90	-75
Groundnut	Yield	7	341	241	-26	-2	2	4	200
	Area	134	-1364	-169	155	121	92	301	-129
	Interaction	40	-1123	-28	28	19	-6	71	-29
	Residual	-81	2246	56	-57	-38	12	-276	58

Spices: Bangladesh achieved a steady growth in area, production and yield of all types of spices crops. The highest growth rates were observed in both the area and production of onion, garlic and chili. This is also due to fiscal incentives government gave to spice producers through concessional credit scheme. The program was initiated in the 90s but was never implemented until 2009. Again, the productivity registered the highest growth rate for turmeric followed by onion, and chili. Among different divisions, the overall growth performances was found better in Dhaka, Khulna and Rajshahi division compared to other divisions (Table 5.37).

The highest positive and significant growth rate of onion area and production was found in Rajshahi division during 2000-2004. The overall growth rate of area and production was also higher in Rajshahi division compared to other divisions. Productivity growth rate was found higher in Rangpur division during 2005-2009 (Appendix Table 56).

Rangpur division registered positive and significant growth rate of garlic area over the different period. All the divisions except Sylhet registered positive growth rate of production during 2000-2004 and 2005-2009. Positive and significant growth rate of yield was found at Barisal and Rajshahi during 2000-2004 and at Rajshahi during 2005-2009 (Appendix Table 57).

All the divisions registered positive growth rates of chili area and production during 1995-1999. The highest positive and significant growth rate of yield was found in Khulna division during 2005-2009 (Appendix Table 58).

The positive and significant growth rate of ginger area was observed at Barisal, Chittagong and Dhaka division during 1990-1994 and 2000-2004. The highest production growth rate was found at Barisal division during 2000-2004. Rajshahi division registered positive and significant growth rate of yield during 2000-2004 and 2005-2009 (Appendix Table 59).

The overall growth rate of turmeric area was found higher during 2005-2009 compared to other periods. Most of the divisions registered positive growth rate of area during this period. During

the last decade, all the divisions except Barisal received positive growth rate of turmeric production. The highest positive and significant productivity growth rate was found in Dhaka division during 2005-2009. Most of the divisions registered positive productivity growth rate during the last decade (Appendix Table 60).

Table 5.37 Growth rates of area, production and yield of major spices by division, 1990-2009

Crop	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
1. Onion								
Area	-0.7*	-1.1***	6.1***	8.1***	10.4***	-4.5***	2.9***	7.0***
Production	-0.5 ^{ns}	0.9 ^{ns}	8.9***	11.3***	14.2***	-0.6 ^{ns}	3.3***	10.2***
Yield	0.2 ^{ns}	2.0***	2.7***	3.2***	3.8***	3.9***	0.4 ^{ns}	3.2***
2. Garlic								
Area	1.9***	0.7***	3.0***	4.5***	12.2***	-3.3**	3.5***	5.6***
Production	0.6 ^{ns}	1.1**	3.4***	6.9***	14.7***	-2.8**	5.0***	7.4***
Yield	-1.4***	0.4 ^{ns}	0.4 ^{ns}	2.4***	2.5***	0.5 ^{ns}	1.3**	1.8***
3. Chili								
Area	3.6**	3.1**	6.1***	6.5***	1.0 ^{ns}	4.0 ^{ns}	4.1**	4.7***
Production	5.1***	5.7***	8.2***	12.6***	3.5***	7.3***	6.6***	7.2***
Yield	1.5***	2.6***	2.1***	6.1***	2.4***	3.2***	2.4***	2.5***
4. Ginger								
Area	-0.7 ^{ns}	3.1***	2.2***	0.5*	1.3***	-4.9***	0.1 ^{ns}	1.8***
Production	2.3 ^{ns}	4.0***	3.5***	4.1***	3.1***	-4.9***	0.7 ^{ns}	2.8**
Yield	3.0**	0.9 ^{ns}	1.3***	3.6***	1.8***	0.0 ^{ns}	1.8**	1.0 ^{ns}
5. Turmeric								
Area	-0.1 ^{ns}	3.1***	2.3***	2.7***	0.3 ^{ns}	0.5 ^{ns}	0.3 ^{ns}	1.8***
Production	-0.9**	6.5***	3.3***	9.5***	3.4***	9.0***	3.5**	5.9***
Yield	-0.8 ^{ns}	3.5***	0.9 ^{ns}	6.8***	3.1***	8.5***	2.8*	4.1***

Note: Area in acre, production in metric ton and yield in ton per acre

‘***’, ‘**’ and ‘*’ indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

Source: Various issues of BBS

Sources of spices production growth: The sources of change in average spice production in different divisions of Bangladesh have been presented in Table 5.38. The table reveals that the change in both mean area and yield are positively contributed to changes in the mean productions of different spices at national level with slight exception in chili production. But the contribution of mean area change was much higher than that of mean yield change for onion and garlic production, whereas it was reverse for the change in mean production of turmeric, chili, and ginger.

At the divisional level, the change in mean yield was positively contributed to changes in the mean productions of turmeric and chili in all the divisions except Barisal for turmeric production. Again, change in mean area was the main source of change in the mean production of garlic production in all the divisions. The main sources of changes in both area and yield were observed in different divisions for onion and ginger production.

Table 5.38 Growth decomposition in production of spices in Bangladesh, 1990-2009 (%)

Crop	Effect	Division							Bangla desh
		Barisal	Chittagong	Sylhet	Dhaka	Khulna	Rajshahi	Rangpur	
Onion	Yield	81	133	1206	25	64	22	73	34
	Area	-14	-20	-1383	81	53	92	142	79
	Interaction	-33	13	-277	5	17	15	15	13
	Residual	66	-26	554	-11	-34	-29	-130	-26
Garlic	Yield	-219	35	-7	23	64	34	78	42
	Area	324	66	179	79	50	85	126	73
	Interaction	5	0	72	3	14	19	13	15
	Residual	-10	-1	-144	-5	-28	-38	-117	-30
Turmeric	Yield	-1168	55	121	63	72	72	157	72
	Area	-2095	50	-30	46	37	13	38	33
	Interaction	-3363	4	-9	9	8	-15	-16	4
	Residual	6726	-9	18	-18	-17	30	-79	-9
Chili	Yield	302	199	416	90	87	76	89	111
	Area	-138	-108	-81	17	9	42	83	-25
	Interaction	62	-9	235	7	-4	18	-31	-14
	Residual	-126	18	-470	-14	8	-36	-41	28
Ginger	Yield		-58	9	57	96	62	228	27
	Area		-77	109	50	3	32	157	8
	Interaction		-235	18	7	-1	-6	36	-65
	Residual		470	-36	-14	2	12	-321	130

5.3 Concluding Remarks

Detailed growth analysis revealed that the highest and impressive growth performances have been observed in maize among cereal crops during 1990-2009. But, the overall growth performance of *Boro* rice is better than other rice crops. Among vegetable crops, the overall growth rates of area and production of potato, pointed gourd and okra have been found impressive. Although the growth rates of area and production of various pulse crops are negative, the growth rates of yields are positive due to adoption of improved technologies. The overall growth performances of onion and garlic are found to be excellent among spices crops. On the other side, the growth rates of area, production and yield of mango show impressive performance compared to other fruits. The incentive price and lucrative profitability of the above commodities encouraged farmers to continue their cultivation for a long period that ultimately contributed to register impressive growth rates.

Decomposition analysis reveals that changes in mean area was the principal contributor to change in the mean productions of *Aus*, *Boro*, maize, vegetables, pulses, mustard, banana, jackfruits, onion and garlic at national level during 1990-2009. This means that the change has come through the expansion of area under the aforesaid crops. Again, the main source of change in mean productions of *Aman* rice, wheat, groundnut, mango, turmeric, chili, and ginger at national level was due to change in mean yield of these crops.

**INTERNATIONAL COMPARATIVE GROWTH PERFORMANCE
OF MAJOR FOOD COMMODITIES**

6.1 Background

In order to gain some perspective on how rapid (or slow) growth has been occurred in Bangladesh, the trends and growth rates of area, production and yield of major food commodities of Bangladesh have been compared with the trends and growth rates of those in neighbouring countries like India and Pakistan using FAO statistics.

6.2 Trend of Area, Production and Yield of Food Commodities

An index approach considering five years average was applied to show the trend of area, production and yield of different food commodities in Bangladesh and compared those with India and Pakistan.

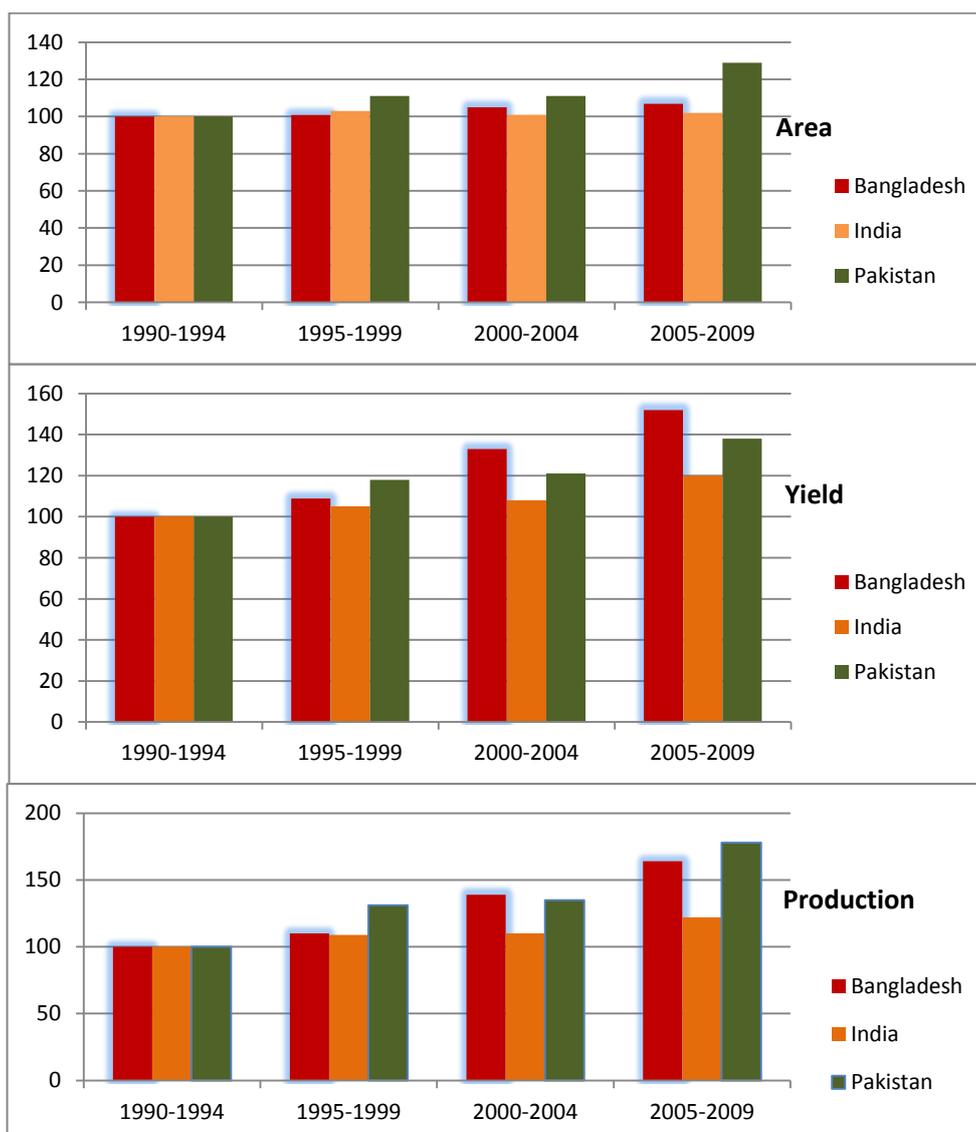
Cereal crops: The indices prepared for area, production and yield of major cereal crops for Bangladesh, India and Pakistan represented an increasing trend over the period from 1990-1994 to 2005-2009. The overall increasing trends in area, production and yield for rice and wheat were higher for Pakistan compared to Bangladesh and India. Despite decreasing trend in area and production, Bangladesh experienced an increasing trend in the productivity of wheat over the period of 1990-2004 due to adoption of improved technology. An exceptionally higher trend in the area, production and yield of maize was found in Bangladesh compared to India and Pakistan over the period from 2000-2004 to 2005-2009 (Table 6.1 & Figure 6.1).

Table 6.1 Comparative indices of area, production and yield of cereal crops, 1990-2009

Time period	Bangladesh			India			Pakistan		
	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield
Rice									
1990-1994	100	100	100	100	100	100	100	100	100
1995-1999	101	110	109	103	109	105	111	131	118
2000-2004	105	139	133	101	110	108	111	135	121
2005-2009	107	164	152	102	122	120	129	178	138
Wheat									
1990-1994	100	100	100	100	100	100	100	100	100
1995-1999	124	148	119	108	121	111	103	115	111
2000-2004	122	150	122	109	128	118	102	128	125
2005-2009	74	79	108	113	134	119	108	146	136
Maize									
1990-1994	100	100	100	100	100	100	100	100	100
1995-1999	97	102	108	105	118	113	109	128	118
2000-2004	865	3763	383	116	144	124	110	160	145
2005-2009	4347	26366	596	134	187	139	118	273	232

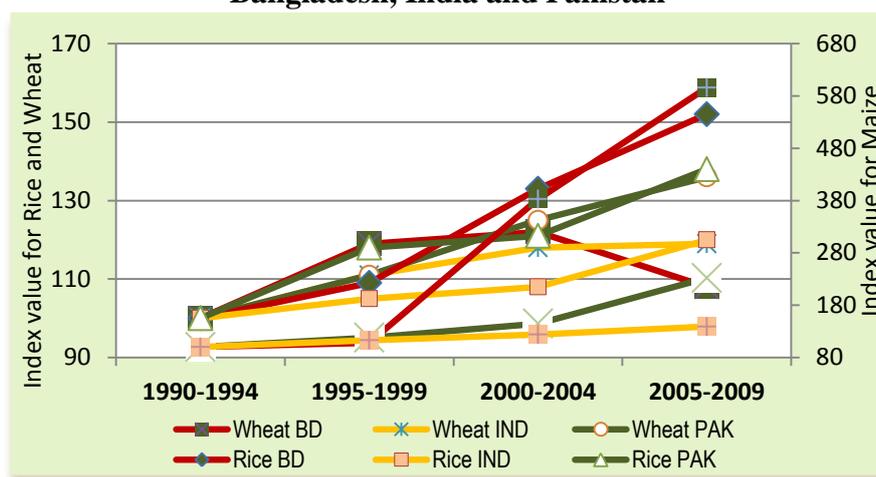
Note: Area in acre, production in metric ton and yield in ton per acre
Source: FAOstat

Figure 6.1 Comparison of area, production and yield indices for rice in Bangladesh, India and Pakistan



While expansion of land area of production by Bangladesh, India and Pakistan depends on several other factors, changes in the index on yield reflects effort put by each country to increase productivity of their land. Figure 6.2 compares indices of yield of rice, wheat and maize by Bangladesh, India and Pakistan. Red line is for Bangladesh, yellow lines are for India and Green line for Pakistan. It shows that wheat production Pakistan achieved the highest yield growth over the past two decades. In terms of increased in rice and maize yield, Bangladesh had more success than its neighbors.

Figure 6.2 Comparison of yield indices for rice, wheat and maize in Bangladesh, India and Pakistan



Fruits: Over the past twenty years, in production, area and yield of Banana, India’s expansion rate as much higher than that of Bangladesh while Pakistan’s yield decreased. Bangladesh’s success in Banana yield is not robust as it was fluctuation and over a period of 20 years it was only 2% growth in yield.

Table 6.2 Comparative indices of area, production and yield of fruits

Time period	Bangladesh			India			Pakistan		
	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield
Banana									
1990-1994	100	100	100	100	100	100	100	100	100
1995-1999	101	98	96	111	149	134	158	109	72
2000-2004	114	101	88	122	164	135	188	167	93
2005-2009	141	143	102	162	264	163	210	178	89
Mango									
1990-1994	100	100	100	100	100	100	100	100	100
1995-1999	102	103	101	119	113	94	107	115	107
2000-2004	103	116	112	147	115	78	117	128	109
2005-2009	299	405	135	193	136	70	192	218	114
Pineapple									
1990-1994	100	100	100	100	100	100	--	--	--
1995-1999	100	98	98	129	121	93	--	--	--
2000-2004	106	108	101	132	132	100	--	--	--
2005-2009	122	154	127	137	144	105	--	--	--

Note: Area in acre, production in metric ton and yield in ton per acre

Source: FAOstat

In mango production, Bangladesh’s yield growth was 35% in 20 years period which is only 14% in India and for it Pakistan it reduced by 30% for the same period. For Pineapple, Bangladesh achieved 27% growth in yield in 20 years while India achieved only 5% growth in the same period (Table 6.2).

Vegetables: The area and production indices prepared for vegetables show a very exciting result. In all the countries (Bangladesh, India and Pakistan) there was increasing trend in these indices from 1990-1994 to 2005-2009. The overall increasing trends in area and production are higher for Bangladesh compared to other two countries. The productivity indices shows

decreasing trend for Pakistan, whereas a fluctuating trend is observed in case of Bangladesh (Table 6.3).

Table 6.3 Comparative indices of area, production and yield of vegetables

Time period	Bangladesh			India			Pakistan		
	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield
1990-1994	100	100	100	100	100	100	100	100	100
1995-1999	114	113	99	114	117	103	120	127	106
2000-2004	136	134	99	128	142	111	131	135	104
2005-2009	191	223	116	139	165	118	153	153	100

Note: Area in acre, production in metric ton and yield in ton per acre

Source: FAOstat

Pulses, oilseeds and spices: The area indices constructed for pulses show decreasing trends for Bangladesh, India and Pakistan over the period from 1995-1999 to 2005-2009 compared to their base period. Despite the decreasing trend in area, the productivity indices depict an impressive increasing growth for all countries (Table 6.4).

In case of Bangladesh, a decreasing trend in oilseed area index, while a fluctuating trend in production is observed. In India, the indices for both area and production have been fluctuating over the study period. Pakistan, on the other hand, experienced a significant growth in area, production and yield of oilseed (Table 6.4).

Table 6.4 Comparative indices of area, production and yield of pulses, oilseeds and spices

Time period	Bangladesh			India			Pakistan		
	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield
Pulses									
1990-1994	100	100	100	100	100	100	100	100	100
1995-1999	91	94	104	98	109	111	99	117	119
2000-2004	64	68	106	91	100	111	87	97	112
2005-2009	41	49	118	98	108	110	91	113	125
Oilseeds									
1990-1994	100	100	100	100	100	100	100	100	100
1995-1999	98	102	104	106	110	103	111	112	101
2000-2004	73	80	111	97	99	101	112	134	119
2005-2009	68	83	122	112	133	118	118	153	130
Spices									
1990-1994	100	100	100	100	100	100	100	100	100
1995-1999	101	103	101	114	118	106	106	115	110
2000-2004	107	119	110	101	131	134	112	120	117
2005-2009	137	258	187	101	155	156	233	128	156

Note: Area in acre, production in metric ton and yield in ton per acre

Source: FAOstat

The indices revealed that Bangladesh and Pakistan performed relatively better in spices production compared to India with an increase in the index value for area, production and yield over the study period. On the other hand, India experienced an impressive growth in production and yield but a fall in area index for spices (Table 6.4).

Livestock products: The demand for livestock products is increasing day by day throughout the world for many reasons. Therefore, almost all the countries in the world have to increase

the supply of livestock products to fulfill their country's increasing demand. The indices constructed for livestock production revealed that Bangladesh, India and Pakistan experienced an increasing trend of the production of livestock products including poultry meat, beef, milk and egg over the period from 1990-1994 to 2005-2009 (Table 6.5).

Table 6.5 Comparative indices of production and yield of livestock products

Time period	Bangladesh		India		Pakistan	
	Production	Yield	Production	Yield	Production	Yield
Poultry meat						
1990-1994	100	100	100	100	100	100
1995-1999	110	96	116	100	158	89
2000-2004	144	96	175	117	170	96
2005-2009	190	96	293	132	257	99
Beef						
1990-1994	100	100	100	100	100	100
1995-1999	123	109	104	101	101	104
2000-2004	140	114	106	102	110	103
2005-2009	168	115	116	102	134	103
Milk						
1990-1994	100	100	100	100	100	100
1995-1999	121	94	126	118	140	113
2000-2004	132	93	150	128	166	124
2005-2009	168	88	183	147	197	134
Egg						
1990-1994	100	100	100	100	100	100
1995-1999	168	100	124	107	121	101
2000-2004	217	102	175	106	154	98
2005-2009	263	99	231	118	200	98

Note: Production in metric ton and yield in ton per acre

Source: FAOstat

The productivity indices of livestock products revealed a mixed scenario for the different countries. Bangladesh experienced decreasing trend in the productivity of poultry meat and milk, whereas increasing trends for beef and egg. India experienced increasing trend in the productivity of all livestock products except egg, but opposite scenarios were observed in Pakistan. Only the productivity of milk production showed increasing trend over the study period in Pakistan (Table 6.5).

6.3 Growth of Area, Production and Yield of Major Food Commodities

Cereal crops: Data on three cereal crops including rice, wheat and maize were analyzed and compared in this study. During the period from 1990 to 2009, Bangladesh performed the best in producing maize in terms of higher growth rates in area, production and yield compared to India and Pakistan. On the contrary, the country experienced negative growth rates in the area and production of wheat in the same period. Pakistan achieved the highest growth rates in the area and production of rice, and the production and yield of wheat compared to Bangladesh and India. India experienced the highest growth rate only in the area of wheat (Table 6.6).

Table 6.6 Growth rates of area, production and yield of food commodities, 1990-2009

Crops	Bangladesh			India			Pakistan		
	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield
Cereal crops									
Rice	0.5***	3.4***	2.9***	0.1 ^{ns}	1.2***	1.2***	1.6***	3.6***	2.0***
Wheat	-1.9**	-1.2 ^{ns}	0.7 ^{ns}	0.8***	1.9***	1.1***	0.4***	2.4***	2.0***
Maize	25.0***	38.0***	12.0***	2.0***	4.1***	2.1***	0.9***	6.3***	5.4***
Fruits									
Pineapple	1.2***	2.6***	1.4***	1.9***	2.3***	0.5 ^{ns}	--	--	--
Papaya	9.5***	8.1***	-1.5**	3.5***	8.3***	4.8***	4.7***	1.5***	-3.2***
Banana	2.2***	2.1***	-1.0 ^{ns}	3.2***	6.2***	3.0***	5.0***	4.9***	0.0 ^{ns}
Mango	6.3***	8.3***	2.0***	4.4***	1.9***	-2.5***	6.3***	4.7***	0.7***
All pulses	-6.2***	-5.1***	1.1***	-0.2 ^{ns}	0.3 ^{ns}	0.6**	-0.8***	0.3 ^{ns}	1.1**
Lentil	-4.5***	-3.9***	0.7**	1.3***	1.3***	0.0 ^{ns}	-3.8***	-2.8***	1.0**
Oilseeds	4.9***	6.2***	1.4 ^{ns}	-3.3***	-3.6***	-0.3 ^{ns}	--	--	--
All spices	2.0***	5.9***	3.9***	0.0	3.1***	3.2***	4.9***	1.7***	-3.2**
Garlic	5.6***	7.5***	1.9***	3.7***	4.8***	1.1***	0.2 ^{ns}	-0.3 ^{ns}	-0.5***
Chilies	--	--	--	2.0***	1.3***	-0.9***	--	--	--
All vegetables	4.2***	5***	0.8***	2.1***	3.4***	1.3***	2.7***	2.6***	-0.1 ^{ns}
Cauliflower	3.4***	4.5***	1.1***	1.9***	3.0***	1.1***	2.3***	2.7***	0.4***
Eggplant	12.0 ^{ns}	15.6 ^{ns}	40.2 ^{ns}	4.6***	6.2***	1.6***	1.9***	1.6***	-0.4**
Potatoes	7.3***	9.8***	2.5***	3.1***	4.1***	1.0***	3.7***	6.6***	2.9***
Livestock products									
Egg	--	6.2***	0.0 ^{ns}	--	5.6***	1.0***	--	4.6***	-0.2*
Milk	--	3.3***	-0.8***	--	3.9***	2.4***	--	4.4***	1.9***
Poultry meat	--	4.4***	-0.2***	--	7.1***	1.8***	--	6.1***	0.3 ^{ns}
Beef	--	1.8***	1.0***	--	-0.2*	0.1**	--	4.5***	0.7***
Mutton	--	5.4***	--	--	1.2***	--	--	-1.4*	-0.2**
Fisheries									
Inland capture	--	6.3***	--	--	1.1**	--	--	-2.1*	--
Aquaculture	--	4.7***	--	--	7.9***	--	--	19.7***	--

Note: Growth rates of fisheries have been calculated for 2000 to 2009

Area in acre, production in metric ton and yield in ton per acre

‘***’, ‘**’ and ‘*’ indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

Source: FAOstat

Bangladesh, India and Pakistan registered positive and significant growth rates in area, production and yield of rice during 1995-1999. The productivity growth rate of rice in Bangladesh was higher than that of India and Pakistan during 1995-1999. Bangladesh also experienced better productivity growth in other periods compared to India and Pakistan. Pakistan experienced better growth performance in the area, production and yield of wheat compared to other two countries. The growth rate of area, production and yield of wheat in Bangladesh was higher than that of India and Pakistan during 1995-1999. During the last two decades, Bangladesh registered highly significant growth rates in maize area, production and yield compared to India and Pakistan. Growth rate of maize area, production and yield at Bangladesh was much higher compared to India and Pakistan during 2000-2004 (Appendix Table 61).

Fruits: Based on the availability of data, four popular fruits namely pineapple, papaya, banana and mango were taken into consideration for comparing growth rates. The highest annual growth rates of area, production and yield of mango were observed in Bangladesh and these rates were found to be the lowest in India. Bangladesh also stands better position in producing pineapple production. Although the growth rate of area for pineapple production was the

lowest, the production and yield registered higher growth rates compared to India and Pakistan. The annual growth rates of production and yield of papaya and banana were much higher in India compared to other two countries. But the highest growth rates of area of papaya and banana were found in Bangladesh and Pakistan respectively (Table 6.6).

In 2000-2004, Bangladesh registered the highest productivity growth rate for pineapple which was much higher than India. The negative growth rates of pineapple area, production and yield were found during 1995-1999 for both Bangladesh and India. All the countries exhibit better growth performance of papaya during 1990-1994. Among three countries, India registered the highest positive and significant growth rate of area, production and yield of papaya during 1990-1994. Growth performance of banana was much better in India compared to other two countries. Bangladesh registered positive and significant growth rate for banana area only in 2000-2004, but India registered significant growth rate in area during all the periods. Bangladesh exhibited better growth performances of mango compared to India and Pakistan. Bangladesh registered the highest growth rate of production and yield of mango during 2000-2004 and 2005-2009 compared to other two countries (Appendix Table 62).

Pulses: It includes different types of pulses including vetch, lentil, mungbean, black gram, and chickpea. In spite of the adoption of improved technology of pulses, the area and production registered negative growth rates during 1990-2009 in Bangladesh. Only the growth rate of yield was positive because of adopting improved varieties. During the same period, the area under pulses also showed negative growth rates both in India and Pakistan which were much lower than that of Bangladesh. Both India and Pakistan showed better performance in the production and yield of pulses due to introduction of improved technologies. Therefore, the production and yield registered positive growth rates in both the countries. In the case of lentil, the growth rates of area and production were found to be negative for Bangladesh and Pakistan. India showed better performance in this regard (Table 6.6).

Bangladesh registered negative growth rate of pulses area during different time periods, while India and Pakistan registered positive area growth rate during 2000-2004 and 2005-2009 respectively. However, the growth rate of pulses yield was found mostly positive in Bangladesh compared to other two countries (Appendix Table 63).

Oilseed: Pakistan achieved a steady growth in area, production and yield of oilseed crops. The highest growth rate was observed in oilseed production followed by yield and area. Bangladesh experienced negative growth rates both in area and production, while the growth rate of yield was positive during 1990-2009. The highest growth rate of yield was achieved by Bangladesh compared to other two countries during 1995-1999 (Appendix Table 63).

Spices: Bangladesh did a commendable progress in spices production during the period from 1990 to 2009. Table 6.6 reveals that the growth rates of area, production and yield of spices in Bangladesh were 2.0, 5.9 and 3.9% respectively which were higher than the rates found in India and Pakistan. In the case of garlic, the annual growth rates of area, production and yield were much higher in Bangladesh than that of India and Pakistan. The production and yield of garlic registered negative growth in Pakistan.

Bangladesh achieved significant growth in spices area, production and yield during 2005-2009 compared to other two countries. In the case of garlic, Pakistan achieved a commendable growth rate during 1990-1994. Bangladesh registered positive growth rate of production and yield during different periods as a result the overall growth performance of Bangladesh was better than other two countries (Appendix Table 64).

Vegetables: The overall vegetable sector in Bangladesh showed an impressive growth over time and it has been considered as a potential export sector compared to India and Pakistan. The overall growth rates of area, production and yield of vegetables were 4.2%, 5% and 0.8% respectively in Bangladesh which was higher than India and Pakistan. The annual growth rates of area, production and yield of eggplant, cauliflower and potatoes also much higher in Bangladesh than that of India and Pakistan (Table 6.6).

Bangladesh and India experienced better growth performance of vegetables during 2005-2009, while Pakistan showed better performance during 1990-1994 compared to other periods. The highest growth rate of area, production and yield of vegetables was achieved by Bangladesh compared to other two countries during 2005-2009. Bangladesh registered positive and significant growth rate of area, production and yield of cauliflower and potatoes during 2005-2009 and 1990-1994 respectively (Appendix Table 65).

Livestock products: Livestock products include egg, milk, poultry, beef and mutton. Table 6.6 reveals that the production of livestock products except beef in India and mutton in Pakistan registered positive growth rates in Bangladesh, India and Pakistan during the study period. The reason lies behind the negative growth of beef production is that the majority people in India belonged to Hindu community do not consume beef. Among livestock products, the highest growth rates were observed for egg (6.2%) and mutton (5.4%) production in Bangladesh and for milk (4.4%) and beef (4.5%) in Pakistan. Only the production of poultry meat registered the highest growth (7.1%) in India. The lowest growth rates were apparent in the production of milk and poultry in Bangladesh compared to other two countries (Table 6.6).

Bangladesh experienced a higher growth rate of egg production than that of India and Pakistan during 1990-1994, 1995-1999 and 2000-2004 respectively. Bangladesh registered negative growth rate of milk yield over different periods, while India and Pakistan registered positive growth rates of production and yield of milk throughout different study periods. In the case of poultry meat production, Pakistan experienced the highest growth rate compared to other two countries during 1990-1994. Bangladesh registered negative growth rate of poultry meat yield during different time periods, while India experience negative growth rate during 2000-2004 and 2005-2009. Pakistan experienced better growth performance of beef production compared to other two countries. The highest positive and significant growth rate of beef yield was found in Bangladesh compared to India and Pakistan during 1995-1999. The maximum numbers of positive growth rates of mutton production were found in both Bangladesh and India. The highest growth rate of mutton production was achieved by Bangladesh during 1990-1994 and 2005-2009 (Appendix Table 66).

Fisheries: The fisheries sector of Bangladesh also registered positive growth over the time. The highest growth rate was for inland capture fisheries in Bangladesh, whereas it was negative in Pakistan. In the case of aquaculture, the highest growth rate was found in Pakistan and the lowest in Bangladesh (Table 6.6).

Bangladesh experienced the highest growth rate of inland capture fisheries compared to India and Pakistan during 2005-2009, while Pakistan registered the highest growth rate of culture fisheries during 2000-2004 (Appendix Table 67).

6.4 Concluding Remarks

Growth performance scenario reveals that the overall growth performances of rice and wheat were admirable for Pakistan compared to Bangladesh and India. Excellent growths in area, production and yield of maize were found in Bangladesh. The overall growth performance of

mango and papaya were observed in India and Bangladesh respectively. Although the growth rates of area and production of pulses were negative for three countries, productivity growth rates were found positive due to adoption of improved technologies. In Bangladesh, the overall growth rates of oilseeds were impressive but it was negative for India. The growth performances of vegetables, potato, egg and mutton were found inspiring for Bangladesh compared to other two countries. Fisheries sector also performed better both in Bangladesh and Pakistan.

DIVERSIFICATION IN CONSUMPTION

7.1 Background

The consumption pattern of Bangladeshi people has changed and diversified over the years due to various reasons including higher growth in income, changing lifestyle, education, urbanization, greater health consciousness, and improved availability of different foods. Besides, diversification of food consumption may promote diversification in agriculture. This section presents the consumption pattern of different food commodities and its changes over the time through analyzing time series and various HIES data. It has analyzed time series data from 1990 to 2009 on major food commodity production, export and import to estimate the net consumption. A comparative scenario of domestic consumption by residence, poor⁴ and non-poor, operated land, diversified and non-diversified farmers, and top and bottom quintile groups has been provided in this section. The analysis of consumption data for various socio-economic classes living in rural and urban areas and the agricultural households with diversified and non-diversified production using HIES data from 2000, 2005 and 2010.

7.2 Growth Rates of Per Capita Availability of Foods

The availability and access of food are the major elements of food security. Table 7.1 reveals that the per capita availability of all the food items except pulses was increased to some extent over time. Both higher domestic production and importation contributed to increase the availability of food commodities in Bangladesh. The highest growth rate registered in maize availability (36.47%) followed by the availability of egg (12.75%), potato (9.77%), and meat (7.38%) during the period from 1990 to 2009. The per capita availability of mango, onion, jackfruit, pointed gourd, papaya, sugar and garlic also registered impressive growth rates during that period compared to other food items. The growth rates of some vegetables namely okra, cabbage, brinjal, cauliflower, and bitter gourd were found to be highly positive that ranged from 2.20% to 5.14%. Chili, turmeric and ginger also registered positive growth rates during the study period. Very little but positive growth rates were observed in milk and milk products, banana and radish, whereas negative growth rate was for the availability of pulses.

7.3 Trend of Per Capita Availability of Major Food Items

The indices constructed for different food items are presented in Table 7.2. The overall highest increasing trends were observed in the consumption of egg, fish, meat, sugar, potato, and pointed gourd. In the case of spices, the indices showed decreasing trend during 1995-1999 whereas showed increasing trend during 2005-2009. The overall increasing trend was observed for chili consumption over the study period. Except tomato and radish, the per capita consumption showed increasing trend for rest of the vegetables over the period from 1990-1994 to 2005-2009. The indices constructed for different fruits implied decreasing trend over the period from 1995-1999 to 2000-2004, except papaya. On the other side, the per capita consumption of these fruits registered increasing trend during 2005-2009 compared to base period (Table 7.2).

⁴Using the upper poverty line, the annual per capita nominal income of the poor is Tk. 1270.93 at the national level, Tk. 1211.57 in the rural area and Tk. 1545.96 in the urban area (HIES, 2010).

Table 7.1 Per capita availability (gm/day) of major food items and their growth rates

Food items	Availability (gm/day)				Growth rate (%), 1990-09
	1990-1994	1995-1999	2000-2004	2005-2009	
Rice & wheat	485.97	468.71	566.58	599.29	1.55
Maize	0.07	0.06	1.77	14.94	36.47
Pulses	14.74	12.58	11.43	9.04	-3.50
Edible oils	5.94	5.67	2.61	NA	1.08
Sugar	6.47	7.05	8.02	17.68	6.04
Meat (beef & mutton)	7.80	10.22	15.61	22.90	7.38
Milk & milk products	24.55	32.77	29.53	30.94	0.78
Egg (No./month)	1.28	1.54	3.47	7.68	12.75
Fish	6.43	29.42	46.15	57.59	4.68
Onion	5.18	3.72	4.18	16.33	6.77
Chili	1.47	1.56	2.94	3.01	5.21
Garlic	0.95	0.86	0.96	2.60	6.01
Turmeric	0.97	0.90	1.00	2.10	4.79
Ginger	1.04	0.78	0.96	1.33	1.64
Potato	23.49	28.94	50.82	76.17	8.10
Brinjal	3.37	3.83	5.83	4.92	3.13
Cabbage	1.31	1.73	1.83	2.68	4.35
Cauliflower	1.23	1.26	1.32	2.04	3.07
Bitter gourd	0.34	0.34	0.34	0.41	2.20
Radish	3.18	3.19	3.14	2.81	0.50
Pointed gourd	0.38	0.47	0.62	0.97	6.17
Okra	0.23	0.27	0.32	0.51	5.14
Tomato	1.58	1.46	1.63	2.00	1.55
Mango	3.27	2.97	3.24	10.80	6.94
Banana	11.42	10.20	9.87	12.93	0.51
Jackfruit	4.61	4.37	4.23	15.66	6.37
Pineapple	2.78	2.45	2.56	3.41	1.17
Papaya	0.55	0.64	0.62	1.56	6.13

Source: Various issues of BBS

Table 7.2 Trend of per capita availability of major food items in Bangladesh, 1990-2009

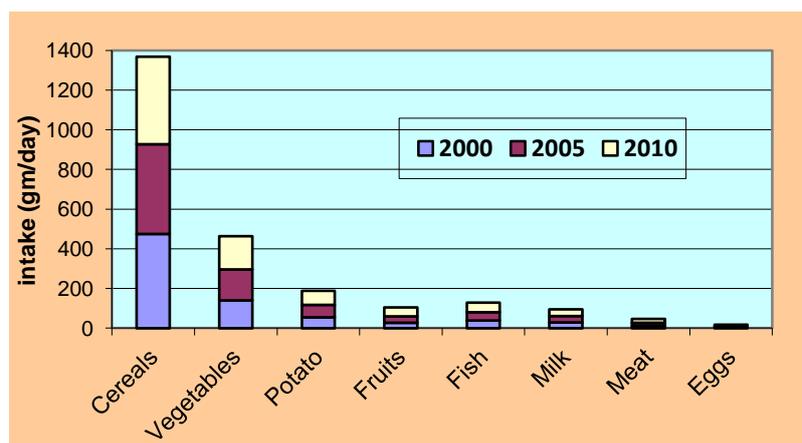
Food items	1990-1994	1995-1999	2000-2004	2005-2009
Rice and wheat	100	96	117	123
Maize	100	79	2502	21122
Pulses	100	85	78	61
Edible oils	100	95	44	NA
Sugar	100	109	124	273
Meat (beef & mutton)	100	131	200	294
Milk & milk products	100	133	120	126
Egg	100	120	270	599
Fish	100	458	718	896
Onion	100	72	81	315
Chili	100	106	200	205
Garlic	100	91	102	274
Turmeric	100	93	104	217
Ginger	100	75	93	128
Potato	100	123	216	324
Brinjal	100	114	173	146
Cabbage	100	131	139	204
Cauliflower	100	102	107	165
Bitter gourd	100	101	100	120
Pointed gourd	100	126	165	259
Okra	100	120	142	225
Tomato	100	92	103	126
Radish	100	100	99	88
Mango	100	91	99	330
Banana	100	89	86	113
Jackfruit	100	95	92	339
Pineapple	100	88	92	123
Papaya	100	116	113	282

Source: Various issues of BBS

7.4 Per Capita Consumption of Major Food Items in Bangladesh

The per capita consumption estimates from different household expenditure surveys (HIES) revealed that a considerable diversification was taken place in human consumption during the last two decades. The per capita intake of cereals has decreased over time in one hand and the intake of non-cereals has increased on the other. The intake of vegetables and potato has also increased over time and has reached almost 236.62 gm/capita/day, close to the recommended norm for achieving balanced nutrition. The intakes of other nutritious and rich foods like fruits, fish, milk and meat have also increased substantially over time (Fig 7.1). Increase in the intake of non-cereal foods over time clearly indicate that Bangladesh must prepare a pragmatic plan to increase domestic production of non-cereal commodities for import substitutions through diversifying its agriculture.

Figure 7.1 Per capita consumption of major foods in Bangladesh



Source: HIES, 2000, 2005 & 2010

7.5 Per Capita Consumption of Major Food Items by Residence

Table 7.3 shows that the per capita consumption of food in Bangladesh increased from 920 gm/day in 2000 to 1000 gm/day in 2010. This increase was true for rural and urban areas also. Households in Bangladesh are gradually changing their diets. Food consumption remains heavily on cereals. But, the share of rice in total food basket declined both in rural and urban areas, while the share of wheat increased from 17.24 gm/day in 2000 to 26.09 gm/day in 2010. Again, sharp increase was taken place in the per capita consumption of potato, edible oil, onion, chicken, egg, fish, milk and fruits both in rural and urban areas over the period from 2000 to 2010. Furthermore, the per capita consumption of vegetables increased in rural areas and mutton consumption increased in urban areas. The level of current consumption of fruits & vegetables, animal foods, edible oils, and sugar are far below the desired level, whereas the consumption of cereals and potatoes are much higher compared to its desired level (BAN-HRDB, 2007). Therefore, the current consumption trend depicts an unbalanced diet which does not provide the basis of an active and healthy life. However, this increasing trend in consumption may lead to further diversification of non-crop agriculture in future if there are enough incentives to cultivate non-cereal crops in Bangladesh.

Table 7.3 Per capita per day intake (gm) of major food items by residence

Food item	2010			2005			2000		
	N	R	U	N	R	U	N	R	U
Rice	416.0	441.6	344.2	439.6	459.7	378.5	458.5	478.8	372.7
Wheat	26.09	23.38	33.69	12.08	7.99	24.52	17.24	14.00	30.12
Potato	70.52	71.74	67.08	63.30	61.93	67.48	55.45	54.71	58.83
Pulses	14.30	13.23	17.30	14.19	12.74	18.63	15.77	14.97	91.04
Vegetables	166.1	170.0	154.9	157.0	156.5	158.7	140.5	141.1	137.9
Edible oil	20.51	18.28	26.74	16.45	14.33	22.92	12.82	11.24	19.11
Onion	21.89	19.90	27.46	18.37	16.11	25.26	15.41	14.08	20.72
Beef	6.84	4.77	12.63	7.78	6.41	11.97	8.30	6.87	13.98
Mutton	0.60	0.55	0.89	0.59	0.57	0.66	0.49	0.43	0.71
Chicken/duck	11.22	9.01	17.42	6.85	6.11	10.63	4.50	3.54	8.41
Eggs	7.25	5.80	11.32	5.15	4.41	7.41	5.27	4.61	7.89
Fish	49.41	45.67	59.91	42.14	39.70	49.57	38.45	37.83	40.89
Milk	33.72	31.78	39.16	32.40	31.03	36.55	29.71	28.99	32.59
Fruits	44.80	42.73	50.59	32.54	32.42	32.90	28.35	26.53	35.63
Sugar/Gur	8.50	7.48	11.37	8.08	7.54	9.73	6.85	6.37	8.78
Outside intake	29.38	28.00	34.97	24.76	23.73	27.90	--	--	--
Miscellaneous	72.42	71.24	75.81	48.38	67.01	68.63	55.44	54.58	54.86
Total	1000	1005	986	948	946	952	920	899	862

Note: N=National, R=Rural, U= Urban Sources: Various HIES, 2012, 2005 & 2000

7.6 Per Capita Consumption of Major Food Items by Poor and Non-Poor

The per capita daily consumptions of major food items for poor and non-poor households are presented in Table 7.4. The overall consumption of non-poor people was 24.5% higher than that of poor people. The consumption of rice, potato and vegetables has increased over time and the gap in the consumption of these commodities for poor and non-poor has narrowed down. However, substantial gap remains in the consumption of quality food items such as meat, fish, egg, milk, fruits and sugar. The per capita daily consumptions of these commodities are much higher (46.1- 86.7%) for non-poor people than that of poor people. The level of consumption of these food commodities except cereals and potatoes even for non-poor people has remained below the desired level for achieving balanced nutrition for people to live a healthy and productive life.

Table 7.4 Per capita intake (gm/day) of major food items by poor and non-poor

Food item	Poor	Non-poor	Both category
Rice	406.19	420.15 (3.3)	416.01
Wheat	20.36	28.73 (29.1)	26.09
Potato	63.44	73.78 (14.0)	70.52
Pulses	10.15	16.22 (37.4)	14.30
Vegetables	141.80	177.25 (20.0)	166.08
Edible oil	14.20	23.41 (39.3)	20.51
Onion	15.69	24.74 (36.6)	21.89
Beef	1.55	9.27 (83.3)	6.84
Mutton	0.11	0.83 (86.7)	0.60
Chicken/duck	4.11	15.09 (72.8)	11.22
Eggs	3.40	9.02 (62.3)	7.25
Fish	31.16	57.81 (46.1)	49.41
Milk and milk products	12.18	43.63 (72.1)	33.72
Fruits	20.46	56.00 (63.5)	44.80
Sugar/Gur	3.32	10.88 (69.5)	8.50
Food taken outside	17.70	35.41 (50.0)	29.83
Miscellaneous	50.28	81.81 (38.5)	72.42
Total	816.00	1085.0 (24.8)	1000

Note: Figures in the parentheses are percent higher consumption over poor people

Source: HIES, 2010

7.7 Per Capita Consumption of Major Food Items by Operated Land

The per capita daily consumption of major food items by operated land in rural areas is presented in Table 7.5. The per capita per day consumption of most food items except fruits has decreased to a large extent for marginal, small and medium category farmers in 2010 compared to 2000 and 2005. For large farmers, the consumption of most rich foods such as fish, meat, fruits, and edible oils has considerably increased during this period. But, the level of consumption of cereals, pulses and milk have decreased for large farmers during this period. However, substantial gap remains in the consumption of quality food items such as fish, meat, fruits, and oils between large farmers and other categories of farmers. Table 7.5 further reveals that the level of cereal consumption for large category farmers shows declining trend but still it is much higher than both national and desired levels. Again, the levels of consumption of fruits & vegetables, pulses, animal foods, and oils for large farmers are below the recommended levels (BAN-HRDB, 2007).

Table 7.5 Per capita consumption (gm/day) of major food items by operated land

Farmers' category	Cereals	Fish	Pulses	Meat	Fruits	Vegetables	Edible oil	Milk
HIES: 2000								
Marginal	367.83	27.00	11.08	11.58	17.75	146.50	8.08	19.00
Small	538.33	40.67	15.67	18.67	30.33	199.33	11.33	43.33
Medium	571.33	41.67	15.33	20.33	34.33	208.67	11.67	47.33
Large	652.00	45.67	17.67	26.33	36.67	235.33	14.00	59.67
HIES: 2005								
Marginal	468.58	37.25	12.17	15.08	29.58	218.00	14.08	22.17
Small	536.00	44.33	13.33	24.33	37.33	235.00	15.33	44.67
Medium	558.00	50.00	14.33	26.00	49.33	245.67	16.00	58.00
Large	631.00	58.67	15.67	30.33	58.00	260.33	18.33	75.67
HIES: 2010								
Marginal	285.25	24.67	7.42	9.75	29.83	149.83	10.75	15.25
Small	322.33	28.00	7.67	15.33	42.33	162.33	11.00	27.00
Medium	346.00	34.00	8.33	15.00	50.33	178.00	11.67	33.00
Large	491.67	53.67	9.67	32.00	108.33	265.33	15.67	48.33

Note: Farmer category: Marginal (0.01-1.49 ac); Small (1.50-2.49 ac); Medium (2.50-7.49 ac); Large (7.50+ ac)
Source: Various issues of HIES

7.8 Per Capita Consumption of Diversified and Non-diversified Farmers

It was assumed that the per capita consumption of major food items will be higher for diversified farmers than that of non-diversified farmers. HIES 2010 revealed that the per capita consumption of major food items for diversified farmers was higher to some extent than non-diversified farmers. Only the per capita consumption of cereals and milk was 11.1 and 14.7% lower for diversified farmers compared to non-diversified farmers respectively. Interestingly, the per capita consumption of vegetables was found to be similar for both the groups. The per capita per day consumption of diversified farmers was found the highest for meat (14.5%) followed by pulses (11.3%), fish (10.4%), edible oil (10.3%), and fruits (6.7%). However, substantial gap remains in the consumption of quality food items such as meat, fish, edible oils and pulses between diversified and non-diversified farmers (Table 7.6). Although the level of consumption of diversified farmers is much higher compared to non-diversified farmers, but the consumption level is not balanced at all.

Table 7.6 Per capita consumption (gm/day) of diversified and non-diversified farmers

Food item	Diversified farmer (non-cereal growers)	Non-diversified farmer (cereal growers)	% higher/lower (-) over non-diversified
Cereals	444.88	494.43	-11.1
Fish	54.09	48.44	10.4
Pulses	15.34	13.61	11.3
Meat	19.68	16.82	14.5
Fruits	55.55	51.85	6.7
Vegetables	257.58	257.50	0.0
Edible oil	21.77	19.53	10.3
Milk	33.30	38.20	-14.7

Source: Author's calculation using HIES 2010 data

7.9 Per Capita Consumption of Bottom and Top Quintile Groups

Table 7.7 reveals that in rural areas the per capita cereal consumption of 20% bottom households has been increasing since 1983-84 but opposite scenario is found for upper 20% households. But in urban areas both the bottom and high income group have started reducing rice consumption since 2005 in favour of a more diversified diet. The policy brief of the MoF, (2012) reveals that the per capita cereal consumption of rich households is lower than that of poor households. But HIES (2010) data shows that both in rural and urban areas the per capita cereal consumption of rich households is higher than that of poor households. However, a different picture might be appeared if the PCC of cereals is analyzed based on quintile grouping (10%) instead of 20% upper and lower household grouping.

The level of consumption of vegetables, pulses, and fish is much higher for high-income group compared to low-income group. Therefore, the balanced consumption of different food items remains an issue for the low-income households. Hossain and Deb (2011) found that the price of pulses, edible oils, fish and meat has been increasing at a much higher rate than the price of rice during 1975-76 to 2008-09, which indicates growing demand-supply imbalance for non-rice food items. They also pointed out that the volatility in food prices in the international market for food commodities will have negative consequences on the food security situation in Bangladesh. Therefore, government must plan to reduce the dependence on world market for basic food items to overcome nutritional imbalance and to reduce volatility in prices of these commodities in the domestic market.

Table 7.7 Trend in the per capita food intake of the bottom and the top quintile groups

Food item	Intake of bottom 20% households (gm/day)				Intake of top 20% households (gm/day)			
	1983-84	1991-92	2005	2010	1983-84	1991-92	2005	2010
Rural area								
Cereals	332	386	427	440	665	647	521	493
Vegetables	98	119	224	212	228	261	231	290
Pulses	5	8	8	10	22	28	16	19
Fish	12	13	21	29	51	60	64	72
Urban area								
Cereals	315	413	417	393	516	470	417	395
Vegetables	107	142	207	200	282	284	287	274
Pulses	11	16	11	9	33	29	26	21
Fish	18	25	30	21	62	81	89	78

Source: Adopted from Deb and Hossain (2011). Author's calculation using HIES 2010 data for the year 2010

7.10 Diversification in Cereal and Energy Consumption

An attempt was made to calculate the share of cereal and energy consumption to total food and total calorie intake at rural, urban and national level respectively using three rounds HIES data (i.e. 2000, 2005 & 2010). The share of cereal food consumption to total food consumption was calculated from per capita per day total food consumption divided by per capita per day cereal food consumption. Similarly, the share of energy consumption is the ratio of total energy consumption from all foods (kcal/capita/day) and total energy consumption (kcal/capita/day) from cereal food. Detailed results are presented in Table 7.8 and 7.9.

7.10.1 Diversification in cereal consumption

The share of cereal consumption ranged from 0.48-0.56 for rural areas, 0.41-0.48 for urban and 0.46-0.55 for national level. These shares show a decreasing trend over the year at all levels. The declining shares imply that the percent share of cereal consumption to the total food consumption is decreasing year after year. The percent change in the share of cereal

consumption to total food consumption was much higher in urban areas compared to rural areas. The cereal consumption share scenario also indicated that diversification in cereal food consumption occurred faster in urban areas compared to rural areas (Table 7.8).

Table 7.8 Diversification index for cereal food consumption by residence, 2000-2010

Residents	Year	Food consumption (gm/capita/day)			Share of cereal consumption	Percent change
		Cereals	Non-cereals	All foods		
Rural	2000	502.80	396.20	899	0.56	--
	2005	485.59	460.41	946	0.51	-8.22
	2010	485.68	519.32	1005	0.48	-13.59
Urban	2000	422.42	448.58	871	0.48	--
	2005	419.32	532.68	952	0.44	-9.18
	2010	402.99	583.01	986	0.41	-15.73
National	2000	486.74	406.26	893	0.55	--
	2005	469.18	478.82	948	0.49	-9.20
	2010	463.99	536.01	1000	0.46	-14.87

7.10.2 Diversification in energy consumption

The diversification index of calorie intake from cereals is calculated and presented in Table 7.9. It is revealed that diversification indices for calorie intake from cereal food followed more or less same direction of trend which was observed in the case of cereal consumption diversification index. At national level, the diversification index of calorie intake from cereal consumption ranged from 0.75 in 2000 to 0.69 in 2010. It indicates that calorie intake from non-cereal foods increased in the country and calorie intake was diversified over the year. Table 7.8 reveals that diversification index for calorie intake decreased by 2.67% in 2005 and 8% in 2010 from 2000. This decreasing trend also indicated that the percent change in the diversification of calorie intake was much lower compared to the percent change in the diversification of cereal consumption.

Table 7.9 Diversification index for energy consumption by residence, 2000-2010

Residents	Year	Calorie intake (kcal/capita/day)			Share of calorie intake from cereals	Percent change
		Cereals	Non-cereal	All foods		
Rural	2000	1746.00	517.18	2263.18	0.77	--
	2005	1693.90	559.26	2253.16	0.75	-2.60
	2010	1691.70	698.65	2390.35	0.71	-7.79
Urban	2000	1470.90	679.09	2149.99	0.68	--
	2005	1462.70	731.14	2193.84	0.67	-1.47
	2010	1408.40	883.57	2291.97	0.61	-10.29
National	2000	1690.90	549.58	2240.48	0.75	--
	2005	1636.80	601.69	2238.49	0.73	-2.67
	2010	1617.20	737.64	2354.84	0.69	-8.00

The diversification indices of calorie intake at urban areas also show a declining trend which ranged from 0.68 in year 2000 to 0.61 in 2010. The diversification index of calorie intake from cereals declined by 1.47% in 2005 and 10.29% in 2010 from the year 2000. In rural areas, the diversification indices of calorie intake also showed declining trend which ranged from 0.77 in

2000 to 0.71 in 2010. The diversification index of calorie intake from cereal consumption declined by 2.60% in 2005 and 7.79% in 2010. The diversification index of calorie intake from cereals was higher at the residents of rural areas compared to the residents of urban areas (Table 7.9).

7.11 Concluding Remarks

Data shows that the per capita availability and consumption of major food items except pulses, has been increased in Bangladesh. Sharp increase has been found in the per capita consumption of potato, edible oil, onion, chicken, egg, fish, milk and fruits both in rural and urban areas. The higher production and importation of these commodities are one of the responsible factors for increasing the per capita consumption of these commodities.

A substantial gap remains in the consumption of quality food items such as meat, fish, milk, fruits and oils between poor & non-poor households, small and large farmers, and upper and lower income groups. The level of consumption of these food items also remains below the desired or recommended level which is important for healthy and productive life.

A considerable diversification in consumption has been taken place slowly in Bangladesh over time. The share of rice in the total food basket has declined, and it is reversed for wheat consumption. The diversification in cereal food consumption occurred faster in urban areas compared to rural areas. Both higher production and importation of rice together contribute to its increased availability, but could not increase its consumption in the country. Rice consumption decreased and wheat consumption increased might be due to change in food habit. The calorie intake from non-cereal foods has increased in the country and it is diversified over time. The calorie intake from cereals is higher at rural areas compared to urban areas.

DIVERSIFICATION IN AGRICULTURAL PRODUCTION

8.1 Background

Diversification of agriculture in Bangladesh is manifestation of a shift of resources from rice to other cereal crops, from cereals to non-cereal crops, and from crops to non-crop agriculture. In theory, it is a strategy used for risk reduction and income growth by commercial operators of agricultural farms. Agricultural 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 degree of specialization at the farm level and reduce the extent of diversity (Alam, 2005).

An attempt has been made in this section to analyze the agricultural diversification both at macro and micro level. District level time series panel data for 10 years (2001-2010) were used in this section to assess the type and degree of agricultural diversification occurred at national level in Bangladesh. Cross-sectional primary data have been used to analyze the factors affecting agricultural diversification at the farm level, and to explore the constraints of agricultural diversification in Bangladesh.

8.2 Status of Agricultural Diversification

Agricultural diversification index (ADI) has been calculated in this study which value varied from 0 to 1. Zero means the farm/region is concentrated in the production of cereal products and 1 means it is concentrated on non-cereal products. If diversity is considered to be moving away from tradition cereal production, then higher the value of the index would indicate more diversification. Table 8.1 shows that the value of ADI is 0.56. The highest agricultural diversification (AD) was observed during the period from 2005 to 2007. After these periods the status of AD was decreased as the value of ADI is 0.58. However, the overall agricultural diversity is increasing with fluctuating nature (Fig-8.1 and Appendix Table 68). The regression equation fitted for trend line also implies that the agricultural diversification in Bangladesh is showing an increasing trend. Agricultural diversification also shows a sharp increase that took place in 2007. The sharp increase in ADI was the combined effect of sharp increase in the productions and prices of some vegetables, spices, fruits, and fish. The commodities which productions increased in 2007 were groundnut, garlic, turmeric, potato, mango and jackfruit. Again the commodities which prices increased were lentil, mustard, chilli, pointed gourd, potato, okra, pineapple and fish. Due to peak in 2007, the trend line shown in Fig 8.1 seems to be little bit misleading, otherwise it would be a fairly flat line.

In the regional context, the value and trend (Fig 8.2) of ADI reveals that the highest AD took place at Chittagong and Barisal region over the time due to the increase of the productions and prices of some non-cereal commodities mentioned above during 2007. Again, the lowest AD took place at Rangpur and Rajshahi region over the years. The percent share of income from cereal crops to the total income was higher than that of the income from non-cereal commodities at Rangpur and Rajshahi region implying a wide scope for diversifying agriculture introducing high value crops and non-crop commodity to the existing agricultural farming in future.

Table 8.1 Average value of agricultural diversification index in Bangladesh by regions

Period	Barisal	Chittagong	Sylhet	Dhaka	Khulna	Rajshahi	Rangpur	Bangladesh
1993-95	0.58	0.59	0.50	0.56	0.55	0.45	0.35	0.52
1996-98	0.67	0.62	0.47	0.58	0.60	0.49	0.38	0.55
1999-01	0.64	0.63	0.51	0.55	0.58	0.46	0.40	0.54
2002-04	0.63	0.63	0.51	0.52	0.58	0.50	0.42	0.54
2005-07	0.67	0.69	0.56	0.61	0.62	0.56	0.43	0.60
2008-10	0.62	0.67	0.55	0.59	0.59	0.57	0.45	0.58
1993-10	0.64	0.64	0.52	0.57	0.59	0.50	0.41	0.56

Figure 8.1 Trend of agricultural diversification in Bangladesh

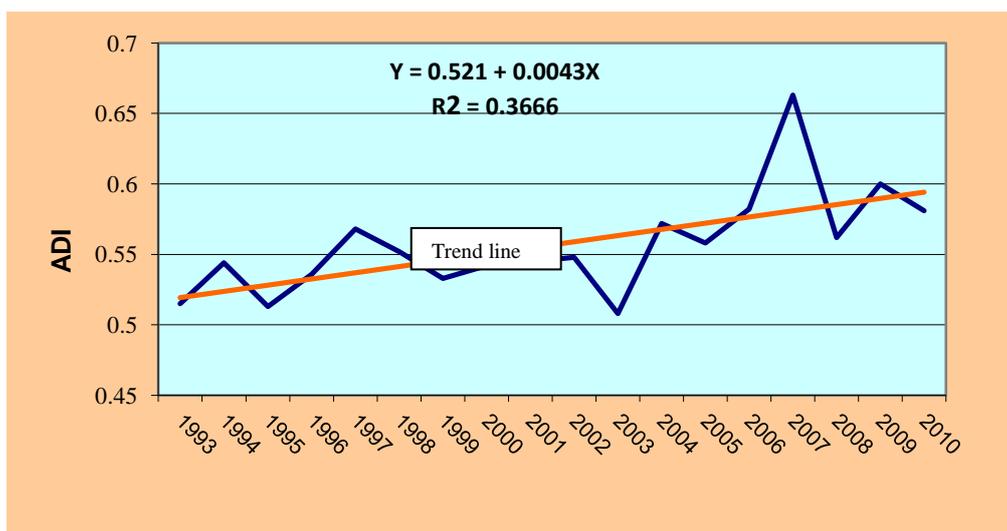
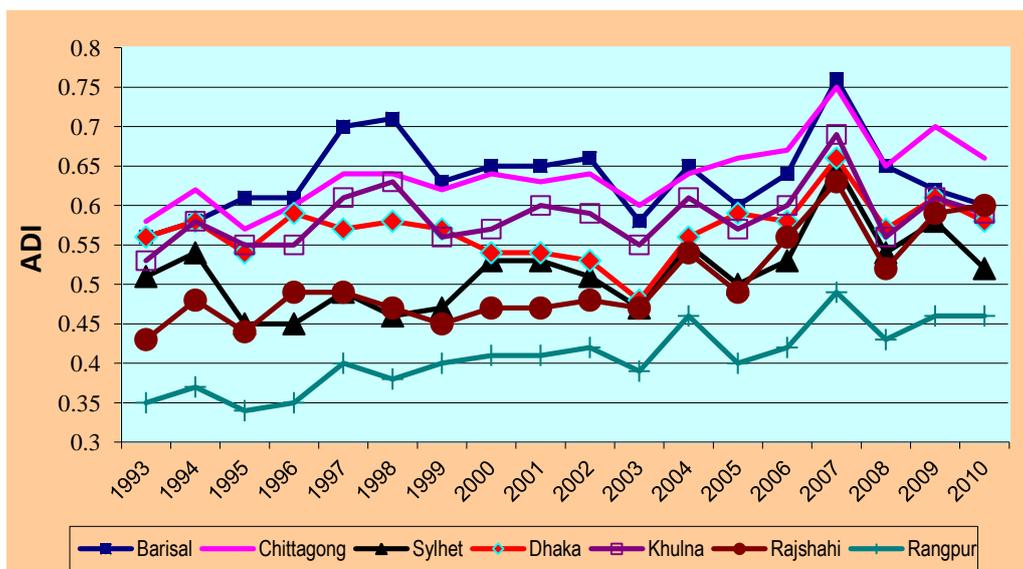


Figure 8.2 Trends of agricultural diversification index in Bangladesh by regions



8.3 Growth Performance of Agricultural Diversification

The overall annual growth rate of ADI is 0.77% during 1993-2010 which is positively significant at 1% level implies that Bangladesh agriculture is diversifying slowly at the rate of 0.77%. The highest growth rate of ADI registered in 2005-2007, but negative growth rate was

observed in the period of 1993-1995. The overall growth scenario reveals a fluctuating but steady trend of ADI in Bangladesh (Table 8.2).

Table 8.2 Annual growth rates of agricultural diversification in Bangladesh, 1993-2010

Period	Barisal	Chittagong	Sylhet	Dhaka	Khulna	Rajshahi	Rangpur	Bangladesh
1993-95	4.25	-0.83	-6.02	-1.91	1.40	1.05	-0.90	-0.17
1996-98	7.71	3.23	0.47	-0.35	6.48	-2.24	3.90	1.53
1999-01	1.69	0.78	5.77	-2.81	3.79	1.95	1.77	1.17
2002-04	-0.23	0.28	3.45	2.70	1.12	5.67	4.43	2.18
2005-07	11.56	6.34	12.94	6.22	9.56	12.98	10.15	8.67
2008-10	-3.38*	0.60	-2.12	0.43	1.84	7.54	3.28	1.64
1993-10	0.35	0.91***	1.00**	0.33	0.46*	1.62***	1.67***	0.77***

Note: ‘*’, ‘**’ and ‘***’ indicate significant at 10%, 5% and 1% level respectively

The regional growth performance of AD reveals that the highest overall growth rates were observed at Rangpur (1.67%) and Rajshahi (1.62%) regions during the period from 1993 to 2010. Although the highest growth rate of ADI was occurred at these two regions, but the level of agricultural diversification was not satisfactory compared to other regions. However, more or less an inverse relationship was observed between the value of ADI and growth rate. The steady growth rates were registered during the period from 2005 to 2007. After this period, the growth performance of ADI was not impressive and this was true for all regions (Table 8.2).

8.4 Comparative Performance of Agricultural Diversification

The comparative performance of agricultural diversification reveals that the highest agricultural diversity was occurred in Pakistan and the lowest in Bangladesh. The average value of ADI for Pakistan and India was 38% and 9% higher than that of Bangladesh. Again, the growth performance of agricultural diversification was much better in Bangladesh compared to India and Pakistan (Table 8.3). The status of detailed ADI for India and Pakistan can be seen in Appendix Table 69.

Table 8.3 Comparative scenario of ADI and its growth in Bangladesh, India and Pakistan

Period	Bangladesh		India		Pakistan	
	ADI	Growth rate	ADI	Growth rate	ADI	Growth rate
1993-95	0.52	-0.17	0.62 (19)	2.41	0.80 (54)	0.94
1996-98	0.55	1.53	0.64 (16)	1.47	0.79 (43)	-0.74
1999-01	0.54	1.17	0.61 (14)	1.97	0.78 (44)	1.34
2002-04	0.54	2.18	0.64 (18)	-4.35	0.78 (45)	-1.43
2005-07	0.60	8.67	0.58 (-3)	-4.00**	0.76 (27)	1.24
2008-10	0.58	1.64	0.56 (-3)	2.13	0.74 (28)	-1.09
1993-10	0.56	0.77***	0.61 (9)	-0.65***	0.78 (38)	-0.43***

Source: Author’s calculation of ADI and its growth rates for India and Pakistan using FAOStat

Figures in the parentheses are percent higher than Bangladesh

8.5 Agricultural Diversification at Household Level

The overall status of agricultural diversification at national level has already been evaluated through secondary data. In this section an attempt was also made to analyze the current status of diversified crop production and diversity in agricultural production at household level.

8.5.1 Production of diversified crops by farm category

An attempt has been made to show the status of the production of different diversified crops by various farm categories using data from HIES 2010. Table 8.4 revealed that there was a

positive relationship to some extent between the quantity of production and farm category for some commodities (e.g. maize, mango, onion, fish & poultry). It means that the amount of production increases with the increase in farm size. Again, small category farmers produced the highest amount of pointed gourd, okra, and potato compared to medium and large category farmers. Medium category farmers produced the highest amount of banana and pineapple among other categories of farmers. In the case of garlic, marginal category farmers produced the highest amount followed by small, medium and large farmers.

Table 8.4 Quantity of production (kg/year) of diversified crops by farm category⁵

Diversified crop	Landless		Marginal		Small		Medium		Large	
	n	Amount	n	Amount	n	Amount	n	Amount	n	Amount
1. Maize	12	70.00	49	118.17	35	160.91	32	314.95	6	316.3
2. Mango	627	104.02	469	165.69	236	155.98	242	919.31	31	7687.1
3. Banana	107	26.67	108	224.00	56	50.00	97	384.38	17	260.0
4. Pineapple	3	498.33	7	680.24	3	878.00	16	1774.40	5	1161.0
5. Pointe gourd	14	537.29	36	493.14	14	955.00	13	625.00	1	750.0
6. Okra	29	427.81	53	655.83	39	1203.10	45	1056.18	8	311.8
7. Potato	67	110.09	198	103.00	111	110.42	136	98.88	24	58.4
8. Onion	26	654.31	109	915.40	64	913.50	77	2382.20	11	9032.9
9. Garlic	11	133.52	73	409.49	52	286.41	66	175.89	9	145.0
10. Fish	628	277.13	456	131.87	225	381.33	222	444.65	30	598.2
11. Poultry	3329	8.25	1647	11.07	628	17.06	567	14.13	55	21.6

Source: Author's calculation using HIES 2010 data

8.5.2 Agricultural diversity at household level

Farm level income information reveals that the income of the diversified farmers was much higher than that of non-diversified farmers. About 89% of the total household incomes of the diversified farmers come from non-cereal production and the rest from cereal production. The non-cereal incomes included incomes received from non-cereal crops, commercial & scavenging poultry, livestock & livestock products, and fish farming. The highest non-cereal incomes came from non-cereal crop production (46%) followed by commercial poultry farming (25%) and fish farming. On the contrary, the lion share of the household income comes from cereal production (64%) for non-diversified farmers. Non-diversified farmers also received some incomes from diversified commodity production. However, the average value of ADI is 0.89 for diversified farmers and 0.36 for non-diversified farmers at household levels (Table 8.5).

⁵Farm category: Landless = 0.0-0.49acre; Marginal =0.50-1.49acre; Small =1.5-2.49acre; Medium = 2.50-7.49acre; and Large = Above 7.50acre

Table 8.5 Farmers' income and agricultural diversification index at household level

Particular	Farmers' category		Both category
	Diversified	Non-diversified	
<i>Sample size (n)</i>	578	382	960
A. Cereal income	16,582 (11)	39,693 (64)	25,778 (22)
Rice and wheat	16,582	39,693	25778
B. Non-cereal income	1,33,104 (89)	22,567 (36)	89,119 (78)
Non-cereal crops	60,830	15,010	42,597
Scavenging poultry	447	349	408
Commercial poultry	33,133	--	19,949
Livestock	16,595	3,617	11,431
Fish farming	22,099	3,591	14,734
C. Total agricultural income	1,49,686 (100)	62,260 (100)	1,14,897 (100)
D. ADI (B÷C)	0.889	0.362	0.776

Figures in the parentheses represent percentage of the total income

8.5.3 Factors affecting agricultural diversification at household level

The diversity of agricultural production is likely to be influenced by different socio-economic factors. At the household level, probit model was used including eight variables to identify the determinants of agricultural diversification in Bangladesh. Initially, 23 variables namely land suitability, soil type, climatic suitability, age/experience of the respondent, education, agricultural training, farm size, family size, organizational participation, extent of extension services, family influence, influence of neighbouring farmers, influence of DAE personnel, level of rural infrastructure, off-farm income, per capita income, farm distance from urban market, CDP areas, availability of agro-processing industries, availability of irrigation, availability of fertilizers and pesticides, availability of improved variety/technology, and access to credit/credit availability were used in the model. Later on many variables were rejected due to non-relationship with agricultural diversity. The maximum likelihood estimates of variables determining agricultural diversification at household level and the marginal effects of those variables are shown in Tables 8.6 and 8.7 respectively.

Land under irrigation facility: Most of the lands of our country are under irrigation facility. Some lands are not getting irrigation facility due to long distance from the irrigation sources. Again, due to higher price many poor farmers irrigated their land manually. Diversified crop cultivation usually needs higher irrigation. Therefore, the amount of land under irrigation facility is an important factor influencing agricultural diversification in the country. It may be said that farmers with higher irrigated land are more diversified than the farmers with lower irrigated land. The coefficient (0.0000752) of this variable is positive and significant at 5% level. It implies that an increase of irrigated land by 100%, keeping other factors constant, the probability of overall agricultural diversification would increase by 0.0075% in the aggregate situation.

Land suitability: Land is the most important factor of production. It provides essential micro nutrients to crops. Non suitability of land generally appears for deteriorating soil fertility of a particular land or suitable lands which are far away from farmer's residence. The lack of suitability land very often prevents farmers to grow diversified crops including garlic, maize, onion, fish and poultry. Therefore, land suitability is an important factor influencing agricultural diversification in the country. The co-efficient (0.0155356) of land suitability was positive and significant at 10% level (in case of one tail) which implied that the probability of

agricultural diversification increases by 1.554% with the increase in the land suitability by 100% keeping other factors constant.

Training: Farmer’s training on any particular crop is important because it can improve their technical skills regarding diversified crop production practices and related aspects. Due to lack of training facilities many farmers cannot harvest good profit through cultivating high-value crops. Therefore, it has good impact on increasing agricultural diversification in Bangladesh. The coefficient of training (0.0091053) was found to be positive and significant at 1% level, which implied that the probability of diversifying agricultural production increases with the farmers having training on agricultural aspects.

Table 8.6 Maximum likelihood estimates of variables determining agricultural diversification at household level

Explanatory variables	Coefficients	Standard Error	z-statistic	Probability (P> z)
Constant	-0.5962248**	0.240730	-2.48	0.013
Irrigated land (Decimal)	0.0015418**	0.000620	2.48	0.013
Land suitability (if suitable=1, 0)	0.2633535*	0.160109	1.64	0.100
No. of training received	0.1866845***	0.051941	3.59	0.000
Extension linkage (weighted score) ^a	0.0775727***	0.017907	4.33	0.000
Family influence in production (**Scale, 0-4) ^b	0.5116649***	0.066243	7.72	0.000
Credit facility (if available=1, 0)	0.2817828*	0.146017	1.93	0.054
Storage facility (if available=1, 0)	0.070211	0.135057	0.52	0.603
Access to market (km)	-0.1420977	0.100331	-1.42	0.157

Note: No. of observation = 960; LR Chi-square (9) = 217.59; Log likelihood = -226.78; Dependent variable=ADI (0 and 1); Pseudo R² = 0.3242; ‘***’, ‘**’ and ‘*’ represent significant at 1%, 5% and 10% level

^aHigher score indicates higher extension linkage and vice versa

^b‘0’ means no influence and ‘4’ means the highest influence

Extension linkage: Farmers in the study areas generally get agricultural information from various extension media such as Sub-Assistant Agricultural Officer (SAAO), neighbouring farmers, fertilizer dealer, radio, TV, newspaper, booklet, agricultural fair, block demonstration, and research institute visit. Therefore, farmers with good extension linkage have more responsive to up-to-date information regarding modern agricultural technologies than that of non-linkage farmers. Therefore, extension linkage should have a positive effect on agricultural diversification in Bangladesh. The coefficient of extension linkage (0.0037835) was positive and highly significant at 1% level, which implied that the probability of diversifying agricultural production significantly increases with the increase in extension linkage in the aggregate situation.

Family influence in production: There are many pocket areas in Bangladesh where many diversified and high-value crops are commercially grown on a large-scale. This might be due to favourable environment, tradition of the area, and family influence in production along with many other socio-economic factors. In this situation, family influence in production may play a significant role in increasing the agricultural diversification in the study areas. The coefficient of family influence (0.0242988) in cultivating diversified crops was found to be positive and significant at 1% level, indicating that the probability of diversifying agricultural production increases with the increase in family influence in production.

Credit facility: Diversified crop cultivation requires larger amount of capital compared to non-diversified crops. Most farmers of our country do not have enough money for diversified farming including fish, poultry and horticultural crops. Therefore, the availability and access to agricultural credit for the farmers are very much important for diversifying their agricultural production. The probit analysis reveals that the probability of agricultural diversification will be increased by 1.32%, keeping other factors constant, if the availability of credit will be increased by 100%.

Table 8.7 Marginal effects after probit

Explanatory variables	Dy/dx	Standard Error	z-statistic	Probability (P>z)
Irrigated land	0.0000752**	0.00003	2.31	0.021
Land suitability	0.0155356	0.01209	1.29	0.199
Training received	0.0091053***	0.00287	3.17	0.002
Extension linkage	0.0037835***	0.00113	3.36	0.001
Family influence in production	0.0249559***	0.00557	4.48	0.000
Credit facility	0.0131809*	0.00732	1.80	0.072
Storage facility	0.0034165	0.00654	0.52	0.601
Access to market	-0.0069307	0.00507	-1.37	0.172

Storage facility: There is a probability of diversifying agricultural production through providing storage facility for agricultural produces in the study areas. The coefficient (0.0034165) of storage facility was found to be positive but not significant at desired level.

Access to market: The minimum distance from home to union *Parished*, home to *Pucca* road, farm to *Pucca* road, and home to market represents a proxy to measure 'access to market'. Access to market is an important variable that help increasing agricultural diversification in the study areas. In other words, the farmers with higher market access are more diversified in agricultural production than that of farmers with less access to market. The coefficient -0.0069307) of this variable is negative and significant at 10% level (in case of one tail). Negative coefficient implies that the probability of agricultural diversification decreases with the increases of distance from home to union *Parished*, home to *Pucca* road, farm to *Pucca* road, and home to market.

8.6 Determinants of Agricultural Diversification at National Level

The determinants of agricultural diversity have already been analyzed using cross-sectional data. An attempt has also been made in this section to identify the factors affecting agricultural diversity at national level. Initially we had planned to include 18 variables in the model. The variables were education, number of extension personnel, climate factors, total arable land under irrigation, prices of major inputs, infrastructure index (score), number of new technology released, farmgate prices of diversified crop outputs, acreage of land, disbursement of agricultural credit, farm machinery, farmers training on technology, number of markets in the municipalities, number of rice mill/feed mill, number of poultry & dairy industry, number of hatchery (poultry & fish), number of youth trained, and number of agro-processing industry. Finally, we could include five variables due to unavailability of district level panel data or no impact of some variables on agricultural diversity. The results of generalized least square (GLS) regression model⁶ as shown in Table 8.8 and 8.9 have been discussed in the following sections.

⁶This technique is applied when the variances of the observations are unequal and there is a certain correlation between the observations. In this case OLS statistically inefficient or even give misleading inference.

The higher real wage rate is expected to influence progressive farmers to switch over from cultivating cereal crops to high value crops in order to make their farming profitable and sustainable. The real wage rate of our country has been increasing over time. Therefore, under subsistence agriculture, real wage rate plays a significant role in influencing agricultural diversification in Bangladesh. Table 8.8 reveals that the overall impact of real wage rate on agricultural diversity at national level is positive and significant. But the marginal impact of this variable is negative. In other words, the crop diversity was found to be higher in those districts where real wage rate was high, but marginal increase of real wage rate decreases the agricultural diversity throughout the country. The coefficient of real wage rate square is found to be negative and highly significant implying that the impact of real wage rate increase on agricultural diversification will be decreased after a certain point.

Table 8.8 GLS regression estimates of variables determining agricultural diversification at national level

Explanatory variables	Coefficients	Standard Error	z-statistic	Probability (P> z)
Constant	0.090446	0.191238	0.47	0.636
Real wage rate (Tk/day)	6.369688**	3.166149	2.01	0.044
Real wage rate square	-32.8782**	14.03646	-2.34	0.019
Per capita road length (km)	334.8362**	133.3799	2.51	0.012
Per capita road length square	-128767.00**	64642.37	-1.99	0.046
Rainfall (mm/year)	0.0000244***	0.0000094	2.58	0.010
Agricultural credit disbursement (Lakh taka/year)	0.00000138***	0.00000045	3.05	0.002
Population (No.)	0.000000204*	0.00000011	1.81	0.071
Sigma_u	0.09037471			
Sigma_e	0.05178045			
Rho	0.75285614			

Note: No. of observations = 203; Number of group = 23; Wald Chi-square (7) = 41.76; Dependent variable= Value of ADI; Prob>chi-square = 0.0000; Overall R² = 0.2039; ***, ** and * significant at 1%, 5% & 10% level respectively

The road network usually facilitates the farmers to market their products to the nearby and distant markets. Due to good communication with the different markets, farmers get fair price for their products which ultimately encourage them to grow more diversified crops. Therefore, the per capita road length of an area influences agricultural diversification to a great extent. A positively significant relationship is found between per capita road length and agricultural diversification in this study. The agricultural diversity will be increased by 0.00936 with the increase of a total 100 km well connected road in the country (Table 8.9).

Table 8.9 Marginal effects of the variables

Explanatory variables	Coefficients	Standard Error	z-statistic	Probability (P> z)
Real wage rate	-0.7650260**	3.166149	2.01	0.044
Per capita road length	272.9506**	133.3799	2.51	0.012
Rainfall	0.0000244***	0.0000094	2.58	0.010
Agricultural credit disbursement	0.00000138***	0.00000045	3.05	0.002
Population	0.000000204*	0.00000011	1.81	0.071

Note: ***, ** and * represent significant at 1%, 5% & 10% levels respectively

The availability of irrigation water is still scarce in many parts of our country. Nevertheless, the price of irrigation water is also very high due to the higher price of diesel and electricity.

Monopoly in the water market is sometimes creates limited access to irrigation for small and marginal farmers. Rainfall in proper time and proper quantity is the solution of all the water related problems to the farmers. Therefore, rainfall significantly influences the diversity of agricultural production throughout the country. The coefficient of annual rainfall is positive and highly significant at 1% level. It implies that agricultural diversification will be increased by 0.00244 with the increase of 100mm rainfall per annum in the country.

Diversified farming such as poultry farming, dairy farming, fish farming, and the cultivation of horticultural crops requires higher investment that cannot afford most of the farmers of our country. Therefore, disbursement of agricultural credit plays an important role in increasing the level of diversification in agricultural production in Bangladesh. The coefficient of agricultural credit disbursement is positively significant at 1% level implies that agricultural diversification will be increased by 0.00138 with the increase of agricultural credit disbursement by one billion taka per year in the country. Finally, population has also some influence on increasing agricultural diversity in the country. The coefficient of population is positively significant at 10% level implies that agricultural diversification will be increased by 0.00000204 with the increase of population by one million.

8.7 Concluding Remarks

More or less a positive relationship is observed between the production of diversified crops and farm category. The average value of ADI and annual growth rate is 0.56 and 0.77% during 1993-2010 respectively. However, the overall agricultural diversification is showing an increasing trend with fluctuating nature. The highest agricultural diversification took place at Chittagong and Barisal region and the lowest in Rangpur and Rajshahi region over the years. However, increased production of fruits, vegetable and spices and their respective increased prices contribute greatly to sharp increase in the agricultural diversification of Bangladesh. Agricultural diversification in Bangladesh is 38% lower than Pakistan and 9% lower than India.

Agricultural diversification in Bangladesh both at household and national levels is influenced by different socio-economic factors. The regression model using panel data shows that national level diversification is significantly influenced by labour wage, road density, rainfall, and agricultural credit disbursement. Again, the probability of agricultural diversification at household level is significantly influenced by irrigated land, agricultural training, extension linkage, heritage in production, and credit facility.

DIVERSIFICATION IN AGRICULTURAL TRADE

9.1 Introduction

Despite the progress made over the last two decades, Bangladesh is yet to achieve self-sufficiency in food production. It has to depend on imports for food availability throughout the year. Bangladesh is a net importer of most commodities including cereals and non-cereals. Moreover, imports of pulses, edible oils, spices, and sugar have been on the rise.. The import bill on food account has grown at more than 10% in the current decade and now accounts for over one-fifth of the export earnings of the country. The volatility of prices in the world market for basic food commodities gets transmitted in the domestic market and contributes to food insecurity of the low-income households (Hossain and Deb, 2011).

In this section, analysis of food commodity trade is done with a view to understand whether pressure from consumers (due to changing food habit) has reshaped the overall export and import performance of agricultural commodities in Bangladesh vis a vis with that of India and Pakistan.

9.2 Performance of Food Commodity Exports and Imports

The performance of the growth of exports and imports for Bangladesh, India and Pakistan over a period of 20 years from 1990 to 2009 has been presented in Table 9.1. A negative figure in imports implies that the country is reducing its dependence on foreign markets. A positive figure on the other hand, suggests that import dependence is growing of the item. Similarly, a negative figure in exports means that country is losing its ability to export perhaps due to domestic demand growth and a positive figure in export means export has been growing perhaps due to production growth.

Table 9.1 shows that for Bangladesh import growths are positive for all the agricultural commodities; for India, rice, cattle and goat imports are negative while for Pakistan, what and chicken import growths are negative. Therefore, while India and Pakistan have been able to reduce their dependence on few of the agricultural products, for Bangladesh it has increased its dependence of foreign markets. For exportable items, it shows that while Bangladesh has increased its export, India and Pakistan experienced reduction in exports in chicken and cattle, and cattle respectively. The result is a bit confusing because while Bangladesh for example increased its import of rice it has also increased its export of rice. Therefore, the following section analyzes net trade figures by commodities.

Cereals: Bangladesh government opened the import food grains to the private sector in 1993. Currently, private sector imports most of the rice and wheat. The import of rice has declined in normal years but increased substantially in the years of floods and cyclones. Overall rice import scenario reveals that Bangladesh, India and Pakistan imported rice from foreign countries to fulfill the country's demand in one hand and exported some special types of rice to other countries for earning foreign exchange on the other. Pakistan registered the highest import growth rate of rice during 1990-1994, while highest export growth rate was achieved by India during 2000-2004 compared to other two countries.

Bangladesh imports wheat from different countries as a result Bangladesh registered positive growth rate of wheat import except in 1990-1994. Import of wheat has increased in recent

years due to (i) decrease in domestic production, (ii) substantial reduction in food aid that the government used to receive in the form of wheat for implementing disaster relief and safety net program, and (iii) increase in demand for products made from wheat flour in urban areas (Hossain and Deb, 2011). Export growth rate of wheat was found higher in Pakistan than that of India. Bangladesh registered positive import growth rate of maize over the different time period, while India and Pakistan registered negative import growth rate during 2000-2004 (Appendix Table 72).

Fruits: The analysis of growth rates using FAO statistics for fruits reveals that Bangladesh did not import or export pineapple and banana. Pineapple export registered positive growth in India. Table 9.1 also reveals that India and Pakistan exports banana while India exports pineapple as well. Export growth rate of banana was found higher in Pakistan than that of India. India and Pakistan registered positive and significant export and import growth rates of pineapple during 2000-2004 respectively. India registered mostly positive growth rates for exporting banana during different time periods (Appendix Table 73).

Table 9.1 Growth rates of import and export of selected food commodities, 1990-2009

Crops	Bangladesh		India		Pakistan	
	Import	Export	Import	Export	Import	Export
Rice	11.6***	50.0***	-32.0**	9.7***	15.8*	4.5***
Wheat	4.7***	--	15.1 ^{ns}	2.9 ^{ns}	-8.1*	79.4***
Maize	49.8***	--	62.3***	53.6***	22.3***	--
Pineapple	--	--	--	23.0***	10.0 ^{ns}	--
Banana	--	--	--	23.1***	--	15.0***
Pulses	12.2***	--	11.0***	11.7***	7.5***	19.0***
Edible oils	5.7***	20.0*	11.9***	11.1***	18.7***	4.2**
Spices	8.6 ^{ns}	25.0***	42.4***	8.1***	2.5 ^{ns}	4.4***
Vegetables	10.3**	12.8***	14.1***	15.6***	7.1***	21.7***
Potato	14.1***	27.8***	16.1*	17.5***	17.2***	21.4***
Chicken	14.8*	--	--	-10.4*	-5.9***	8.4 ^{ns}
Cattle	---	--	-18.1**	-32.2***	--	-12.4 ^{ns}
Goat	--	--	-13.3**	32.3***	--	-8.4 ^{ns}

Note: '***', '**' and '*' indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

Source: FAOstat

Pulses and edible oils: Imports of pulses and edible oils has been increased at an alarming rate in Bangladesh. For instance, the import of edible oils has increased from 73,732 tons in 1990 to 2,86,902 tons in 2004 and further to 3,76,210 tons in 2009 (FAO Stat). Similar trend is observed in the import of pulses. Therefore, the annual importation of pulses and edible oils registered positive and significant growths in Bangladesh. Similar growth rates were observed in India and Pakistan also.. For edible oil, Bangladesh had positive growths in imports as well as exports – implying a substitution of high value exports from Bangladesh (like mustard oil) and a low value imports to Bangladesh (like palm oil). (more details on growth rates are shown in Appendix Table 74).

Spices: The annual import and export of spices exhibited positive growth for all the countries under study. (Table 9.1). Bangladesh registered negative import growth rate of spices during 2000-2004, while positive export growth rate was found during the same period of time improving a growth in production outweighs that of consumption. Pakistan experienced positive import and export growth rate over different periods, while India registered negative export growth rate during 2000-2004 (Appendix Table 74).

Vegetables: Bangladesh is a net exporter of vegetables. It exports a sizeable amount of vegetables every year in the ethnic markets of Middle East, UK and other developed countries of the world. Table 9.1 reveals that India and Pakistan simultaneously imports and exports vegetables from other countries. Vegetable export growth rate of Pakistan was much higher than that of vegetable export in India and Bangladesh. In the case of potato, the annual growth rates of export were much higher compared to import for all the countries. However, the highest growth rate of potato export was found in Bangladesh (27.8%) and the lowest in India (17.5%). Again, Bangladesh experienced negative and significant growth rate of vegetables export and import during 2005-2009. The highest positive and significant growth rate of vegetables import was found in Bangladesh during 2000-2004, whereas India registered the highest positive and significant export growth during 2005-2009. Bangladesh, India and Pakistan experienced positive and significant growth rates of potato for both export and import during 2000-2004, 1990-1994 and 2005-2009 respectively (Appendix Table 75).

Livestock products: The import of chicken showed positive growth rates in Bangladesh during 1990-2009, whereas export growth rate was negative for India and this implies that India has started consuming more chicken now than before and so Bangladesh will find it difficult to import chicken from India as they will have less surplus. In the case of Pakistan, the growth of chicken import was negative but chicken export was positive meaning Pakistan has emerged as a chicken surplus country in the region. Bangladesh does not import or export cattle (perhaps officially and so on it was listed in the FAO statistics) In India, the annual growth rates of goat import was negative but the growth rate of goat export was highly positive (32%) showing the influence of domestic production of goat in India (see Appendix Table 76 for details).

9.3 Share of Net Import and Export in Total Availability of Food Commodities

It has already been mentioned that Bangladesh is a net importer of pulses, edible oils, spices, fruits, sugar, milk and milk products. An attempt is, therefore, made to show the extent of dependency on imports of various food commodities in Bangladesh, and has been compared with the dependencies of those in India and Pakistan using FAO statistics (Tables 9.2-9.5).

Table 9.2 reveals that the average shares of net trade (import) of rice to its total consumption (availability) and production were decreased over the years due to higher domestic production. The average share of net import of rice in its total availability has increased from 0.37% in 1990-1994 to 1.39% in 2005-2009. These shares were found highest during 1995-1999. India and Pakistan are net exporters of rice. The share of their rice export to the total production has been increasing since 1990. In the case of wheat, the average shares of import to its total availability and production were found increasing year after year due to reduction in domestic production and increase in urban demand for wheat. The share of import to its total availability increased from 38.72% in 1990-1994 to 74.94% in 2005-2009 in Bangladesh which was much higher than Pakistan. India was found net exporter in two periods 1990-1994 and 2000-2004. Although the growth rates of area, production and yield of maize are excellent in Bangladesh, the country still deficits in maize production and has to import a huge quantity of maize every year. The highest share (91.63%) of maize to its total availability was imported from other countries in 1995-1999. After that period the share of maize import showed decreasing trend due to higher domestic production. Pakistan also imports maize and the average shares of import to its total availability have been increasing from the period of 1995-1999.

Table 9.2 Percent of net trade of cereal crops (including maize*) of total availability and production during different periods

Crop	Bangladesh		India		Pakistan	
	% of net trade of		% of net trade of		% of net trade of	
	Consumption	Production	Consumption	Production	Consumption	Production
Rice						
1990-94	0.37	0.37	-0.55	-0.55	-27.14	-21.35
1995-99	3.64	3.78	-2.73	-2.66	-36.39	-26.68
2000-04	1.99	2.03	-2.76	-2.68	-39.22	-28.17
2005-09	1.39	1.41	-2.91	-2.82	-50.32	-33.48
Wheat						
1990-94	38.72	63.19	-0.16	-0.16	11.09	12.47
1995-99	49.60	98.42	0.54	0.54	12.94	14.86
2000-04	57.05	132.81	-4.61	-4.41	-2.96	-2.87
2005-09	74.94	298.99	2.09	2.13	3.54	3.67
Maize						
1990-94	9.18	10.11	-0.10	-0.10	0.45	0.45
1995-99	91.63	1094.39	0.22	0.22	0.11	0.11
2000-04	70.19	235.47	-2.83	-2.75	0.19	0.19
2005-09	24.86	33.09	-13.14	-11.61	0.79	0.80

Note: +ve sign represents net import and -ve sign represents net export.

* Maize is a cereal product in the world but in Bangladesh as of now it is a feed item. However, trends in consumption at the household level show that it is also slowly emerging as a cereal item in Bangladesh.

Source: FAO Stat

Table 9.3 reveals that Bangladesh, India and Pakistan are net importer of pulses. But the shares of import to their total availability and production were much higher in Bangladesh compared to India and Pakistan. An increasing trend was observed in the percent share of import to its total availability in Bangladesh during the period from 1990-1994 to 2005-2009. An increasing trend was also found in the net trade of pulses in India during 1995-1999 to 2005-2009, whereas it was fluctuating in Pakistan.

Table 9.3 Percent of net trade of pulses, oilseeds and spices of total availability and production during different periods

Crop	Bangladesh		India		Pakistan	
	% of net trade of		% of net trade of		% of net trade of	
	Consumption	Production	Consumption	Production	Consumption	Production
Pulses						
1990-94	16.37	19.58	3.97	4.13	14.37	16.79
1995-99	16.32	19.51	3.55	3.68	15.89	18.89
2000-04	48.65	94.74	10.07	11.20	25.86	34.88
2005-09	63.34	172.76	15.17	17.88	25.47	34.17
Edible oils						
1990-94	46.43	86.69	-1.26	-1.24	5.13	5.41
1995-99	65.91	193.38	-3.22	-3.12	10.86	12.18
2000-04	70.95	244.26	-5.93	-5.59	38.57	62.79
2005-09	71.22	247.50	-5.51	-5.22	44.74	80.98
Spices						
1990-94	2.84	2.92	-6.33	-5.96	-10.50	-9.51
1995-99	-0.02	-0.02	-8.28	-7.65	-6.39	-6.01
2000-04	13.08	15.04	-10.24	-9.29	-19.43	-16.27
2005-09	2.76	2.84	-13.07	-11.56	-12.72	-11.28

Note: +ve sign represents net import and -ve sign represents net export

Source: FAO Stat

Table 9.3 further reveals that Bangladesh and Pakistan are net importer and India is a net exporter of edible oils. An increasing trend was observed in the percent share of import of edible oils to its total availability both in Bangladesh and Pakistan during the period from 1990-1994 to 2005-2009. In India, the share of export to its total availability has decreased from 5.93% in 2000-2004 to 5.51% in 2005-2009. Again, both India and Pakistan exported a lot of spices to other countries, whereas Bangladesh imports spices from other countries. Bangladesh has already made a commendable success in spices production, but still the county deficits in spices production. Due to increase in domestic production, the share the net trades of spice has decreased from 13.08% in 2000-2004 to 2.76% in 2005-2009 in Bangladesh.

Table 9.4 reveals that Bangladesh is a net exporter of vegetables, whereas India and Pakistan are net importers of vegetables and net exporters of potato and banana. Bangladesh imports a little amount of potato (might be seed potato) every year in spite of huge domestic production. Both India and Pakistan export potato and banana to other countries. The shares of exports to its total availability exhibit an increasing trend over the period from 1990-1994 to 2005-2009.

Table 9.4 Percent of net trade of fruits and vegetables of total availability and production during different periods

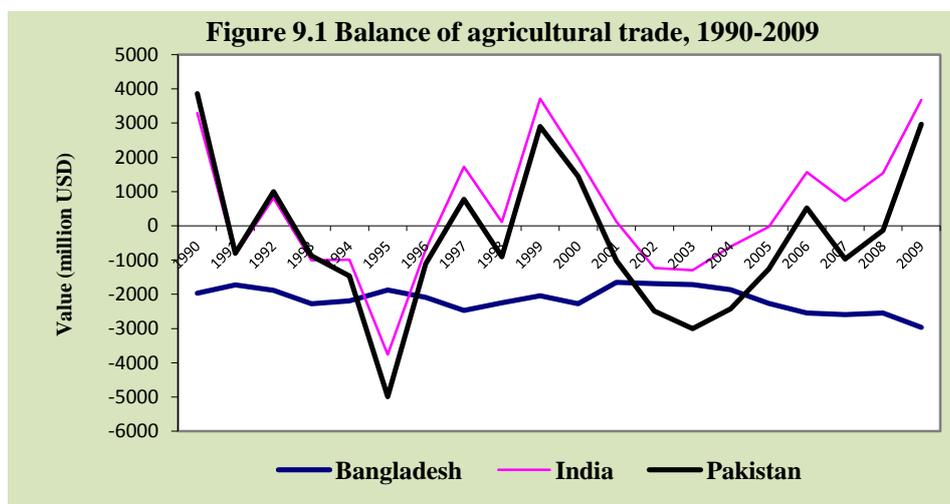
Crop	Bangladesh		India		Pakistan	
	% of net trade of		% of net trade of		% of net trade of	
	Consumption	Production	Consumption	Production	Consumption	Production
Vegetables						
1990-94	0.06	0.06	0.08	0.08	0.93	0.93
1995-99	-0.13	-0.13	-0.02	-0.02	1.24	1.25
2000-04	0.03	0.03	0.05	0.05	0.11	0.11
2005-09	-0.26	-0.26	0.10	0.10	0.92	0.92
Potato						
1990-94	0.10	0.10	-0.05	-0.05	-0.51	-0.51
1995-99	0.04	0.04	-0.12	-0.12	-2.79	-2.71
2000-04	0.08	0.08	-0.16	-0.16	-3.15	-3.05
2005-09	0.06	0.06	-0.35	-0.35	-4.17	-4.00
Pineapple						
1990-94	-0.08	-0.08	-0.01	-0.01	100.00	1.00
1995-99	0.00	0.00	-0.02	-0.02	100.00	1.00
2000-04	0.00	0.00	-0.09	-0.09	100.00	1.00
2005-09	0.00	0.00	-0.29	-0.29	100.00	1.00
Banana						
1990-94	0.00	0.00	-0.01	-0.01	-2.12	-2.08
1995-99	0.00	0.00	-0.04	-0.04	-1.95	-1.91
2000-04	0.02	0.02	-0.07	-0.07	-3.00	-2.91
2005-09	0.00	0.00	-0.11	-0.11	-17.96	-15.23

Note: +ve sign represents net import and -ve sign represents net export

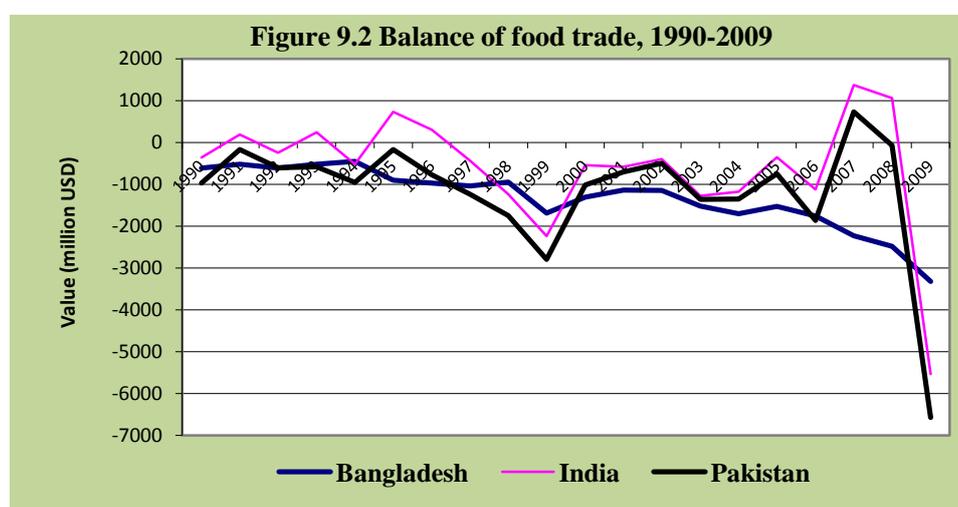
9.4 Balance of Non-cereal Trade

Bangladesh is a net importer of different agricultural commodities including various non-cereal foods. The country spends lots of foreign exchange every year for importing cereal and non-cereal food commodities. Besides, it earns very small amount through exporting different commodities. Therefore, the balance of trade in our country remains negative year after year. FAO statistics show that Bangladesh spent \$3211.356 million for importing different types of agricultural commodities of which 75.3% was for non-cereal food commodities in 2009. On the other side, the country earned \$245.07 million by exporting agricultural commodities of

which 98.6% was for non-cereal exports (Appendix Table 77). Therefore, the country's negative balance of agricultural trade was \$2966.28 million. This negative balance of agricultural trade has been increasing steadily in the last decade. Pakistan's scenario is little bit similar to Bangladesh, but India's balance of trade for agriculture was mostly positive (Fig-9.1).



Bangladesh imports huge amount of food commodities from other foreign countries and also exports a little amount of food commodities to other countries. But the value of import remains much higher than that of export. Therefore, the balance of food trade in Bangladesh remains always negative during its independence. In 2009, Bangladesh spent \$3363.70 million for importing different types of food commodities of which 76.3% was for non-cereal food commodities. Again, it earned \$40.54 million by exporting some food commodities of which 86.8% was for non-cereal food commodities exports (Appendix Table 78). Therefore, the country's negative balance of food trade was \$3323.16 million. This negative balance of food trade has been started increasing steadily from 1999 and continued up to 2009. The trends of balance of food trade for Pakistan and India were found more or less similar during the period from 1990 to 2009 (Fig-9.2).

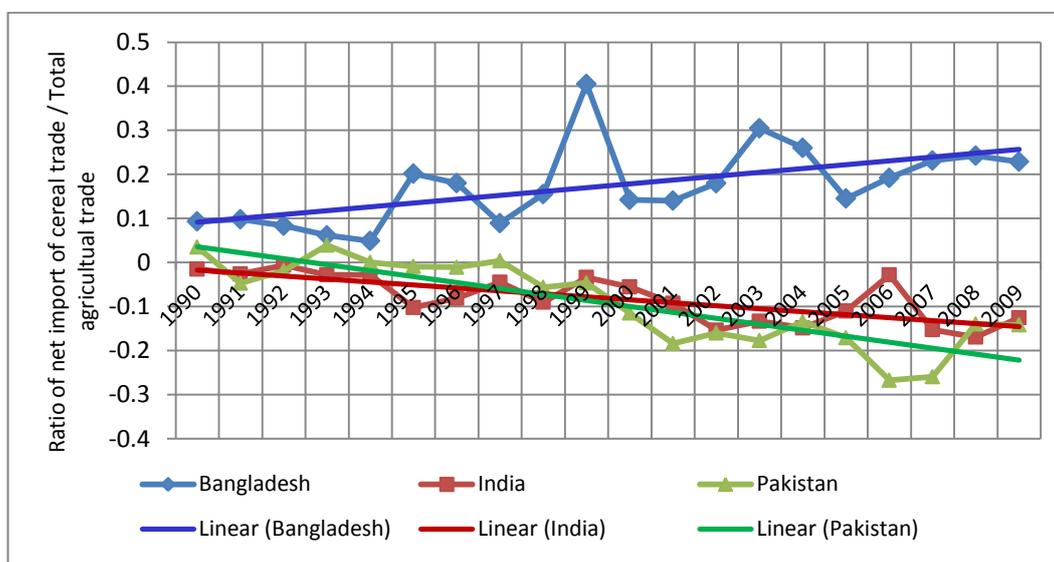


9.5 Diversification in Agricultural Trade

Due to increased demand for non-cereal food, Bangladesh imports a huge amount of non-cereals every year. Therefore, a substantial change has already been occurred in agricultural trade over time. Figure 9.3 presents trends in net import of cereal trade over total agricultural trade for Bangladesh, India and Pakistan. It shows that for India and Pakistan the trend is negative implying that these countries were able to increase their cereal export (because the number is negative), while for Bangladesh it has increased import of cereal over the same period of time. This is despite the fact that both India and Pakistan became more diversified over the same period of time. We have seen, Bangladesh is less diversified than India and Pakistan – this means that our non-cereal production has not grown as much as that of India and Bangladesh and yet Bangladesh’s cereal import has gone up compared to other agricultural imports. This could be either due to population pressure or due to changes in food habit for consumers in Bangladesh. In terms of net growth of population Bangladesh is the least population growth countries in this region. Therefore, positive trend in trade of cereal products (mainly wheat since rice import remained stable) could be due to changes in food habit. In our analysis of HIES data from the household, we have seen that there has been a net growth in consumption of wheat (despite reduction in consumption of all cereal). Based on this it can be argued that positive trend in cereal trade is due to diversification of our consumption from rice to wheat.

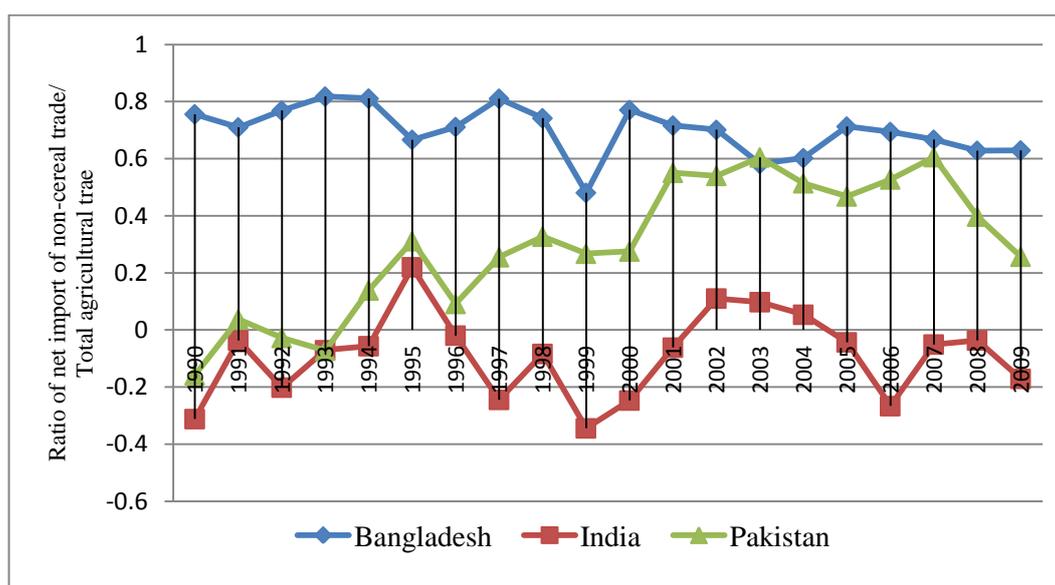
However, to understand the impact of greater agricultural diversification, Figure 9.4 presents the net import trend of non-cereal agricultural trade over total agricultural trade. It shows that for Bangladesh the trend is negative while for India it is fluctuating and average trend has not changed while for Pakistan it is positive. This means, that agricultural diversification in Bangladesh has reduced our dependence on foreign markets in terms of non-cereal trade. It has not been so either for Pakistan or for India. Consequently, it can be argued that despite lower degree of diversification of agriculture in Bangladesh, it has been able to reduce Bangladesh’ dependence of non-cereal products from other countries. This is a positive gain from agricultural diversification programs. It also shows potential in terms of gains from non-cereal diversification of agriculture in Bangladesh.

Figure 9.3 Share of cereal net import over total agricultural trade for Bangladesh, India and Pakistan, 1990-2009



Source: FAOStat

Figure 9.4 Share of non-cereal net import over total agricultural trade for Bangladesh, India and Pakistan, 1990-2009



Source: FAOStat

9.6 Concluding Remarks

Bangladesh is a net importer of most commodities. In some of the products like rice, edible oils, vegetables and potato Bangladesh is both an exporter and an importer due to seasonality in production. The growth rates of both export and import were significantly positive for these commodities during 1990-2009. Import of wheat, maize, pulses, and chicken were significantly positive. Trends in growth of net import (since Bangladesh is a net importer, the analysis is done from net import point of view) shows that Bangladesh's net cereal import to total import has been growing while that of non-cereal import is declining. The trend is different from that of India and Pakistan.

Increasing trend cereal imports is due to changing food habit from rice to wheat bases. This has been confirmed through the HIES data from households. At the same time net deficit in rice has remained constant around 2% of production.

Increasing diversity of agriculture (measured in terms of non-cereal production) in Bangladesh had given some positive dividend as shown through decreasing trend in non-cereal imports. This achievement is much better compared to that of India and Bangladesh despite non-cereal production growth in India and Pakistan was much higher than in Bangladesh. This possibly shows a greater potential to substitute import of non-cereal agricultural products with rise in agricultural diversity for Bangladesh.

CONSTRAINTS TO AGRICULTURAL DIVERSIFICATION

This section contains farmers' problems generally faced during cultivation of diversified crops⁷, reasons for not growing diversified crops, and farmers' opinions towards accelerating agricultural diversification in the study areas. All these information are important and help identification of future policy options for agricultural diversification in Bangladesh.

10.1 Problems of Diversified Crop Production

The respondent farmers who cultivated different diversified crops faced various problems during farming. The reported problems as shown in Table 10.1 and Appendix Tables 79 were linked with three major areas such as production, marketing and social. Detailed descriptions of these problems are given below.

10.1.1 Production problem

Lack of HYV seed: Improved crop variety seed plays a vital role in higher production. Most of the farmers purchased seed/seedlings from the market which were not in good quality. Most of their collected seeds were local or low quality variety. As a result, the growers of different crops mentioned it as one of their major problems in cultivating different high-value crops. More than 38% of maize growers mentioned that lack of HYVs as their major production related problem. Similarly, about 22% garlic and 20% pointed gourd farmers mentioned this as a problem. The farmers of Rangpur, Chittagong and Bogra raised this problem more than the farmers of other districts.

Infestation of insect and diseases: With the expansion of modern agriculture, the infestation of insect and diseases is getting increasing importance. As the farmers of our country are poor and illiterate they do not know how to use the pest management technique to reduce the attack of insect and diseases. As a result, production of different crops is being threatened. Most of the banana growers (78.3%) mentioned infestation of insect and diseases as top ranked production related problem followed by okra growers (70%). Infestation of insect and diseases were also mentioned as major problem by fisheries and poultry farmers. Chittagong, Rangamati, Kushtia and Jessore farmers faced this problem very much.

Higher cost of production: Higher cost of production is one of the major problems in cultivating diversified crops in Bangladesh. Diversified farming required large amount of investment due to land preparation, purchase of seed/chick, fertilizer, labour, feed, insecticides etc which the poor and small farmers of our country cannot easily afford. Higher cost is required mainly for human labour, chick and feed for poultry farm, and fertilizers. Higher cost of production is major problem in the case of poultry farmers (30%) followed by fisheries (20%). Among the different crop growers, the highest 18.3% of the pineapple growers mentioned it as a problem of diversified crop farming. This is a common problem in all the study areas. However, the highest number of farmers of Gazipur, Mymensingh, and Pabna reported this problem.

⁷ Ten crops namely maize, potato, pointed gourd, okra, banana, pineapple, onion, garlic, poultry, and culture fish have been identified and used as diversified crops in this study.

Lack of working capital: This is a common problem of the poor farmers of our country. Most of the farmers of our country are poor as a result they cannot retain much amount of money for diversified farming. Fifty five percent of the pineapple growers mentioned lack of working capital as one of their major problems in farm operation. Banana (41.7%) and fish growers (36.7%) also opined it as a major problem. This was also a common problem to most of the farmers in the study areas. The eighty percent farmers of Rangamati and nearly 57% of Mymensingh reported this as a problem.

Lack of credit: Diversified farming required more working capital compared to other cultivation, but most farmers cannot afford it in our country. For this reason they have to take loan. In the study areas only a few NGOs provided credit for the purpose with high interest rate. The poor farmers also faced problem in getting bank loan for different hard terms and conditions. About 8% of the fish growers mentioned lack of credit facilities as a problem of fish cultivation followed by poultry farmers (5%).

Natural calamities: Farmers of our country face different natural calamities during production process. These natural calamities were storm (*Kalboishaki*), drought, heavy rainfall etc caused substantial damage to the crop especially during the harvesting period. About 25% of the banana growers faced natural calamities during the production process. The problem of natural calamities was not much severe in the case of other crop production in the study areas. This problem was faced by the farmers of Rangpur and Bogra to some extent.

Low yield: Many farmers of our country use local variety seed as a result they obtain low yield. The growers of garlic, maize, onion and potato mentioned low yield as one of their problem. However, this problem was not reported as a major one in all the study areas.

Non-suitability of land: The non-suitability of land was reported to be a problem of cultivating different diversified crops. Non suitability of land generally appeared due to deterioration of soil fertility or cultivable lands are far away from the residence of the farmer. In the study areas, the producers of garlic, maize, onion, fish and poultry faced this problem to some extent.

Higher cost of ploughing: Ploughing is a pre-requisite of cultivating most of the crops. Due to lack of proper ploughing farmers may experience with lower germination rate resulting lower yield. Now a day, most farmers of our country generally plough their land by using tractor or power tiller on hire basis. But due to higher rate of ploughing poor farmers of our country face problem during crop cultivation. About 12% of the garlic growers facing higher cost of ploughing as a production related problem followed by onion growers (5%). This was not a major problem in most of the study areas.

Low quality feed: Feed is an important input in the case of fish and poultry production. Good quality feed play an important role in higher production. Due to higher demand and higher cost, poultry and fish feeds are adulterated by many traders and even by the producers. Due to low quality of feed, the growers of fish and poultry received lower amount of production. About 38% of the poultry growers mentioned it as a problem to get higher production whereas 13% of the fish growers considered it as a problem. The poultry farmers of Gazipur and Chittagong raised this problem very seriously.

Table 10.1 Different problems encountered by diversified farmers during agricultural farming

(Figure in %)

Problems	Banana	Garlic	Maize	Okra	Onion	Patol	Pineapple	Potato	Fish	Poultry
Sample size	n = 60	n = 60	n = 60	n = 60						
A. Production problems										
1. Lack of HYV seed/sucker/chick/fingerling	18.3	21.7	38.3	13.3	10.0	20.0	8.3	15.0	15.0	15.0
2. Infestation of insect and diseases	78.3	20.0	23.3	75.0	31.7	30.0	3.3	36.7	40.0	53.3
3. Higher cost of production	6.7	15.0	8.3	--	13.3	3.3	18.3	13.3	20.0	33.3
4. Lack of working capital	41.7	8.3	21.7	25.0	33.3	1.7	55.0	15.0	36.7	13.3
5. Lack of credit	1.7	1.7	3.3	--	--	3.3	--	--	8.3	5.0
6. Natural calamities (heavy rainfall & drought)	25.0	3.3	1.7	3.3	1.7	8.3	6.7	8.3	1.7	--
7. Low yield	--	1.7	1.7	--	3.3	--	--	5.0	--	1.7
8. Damage of roots & crops	6.6	--	1.7	1.7	3.4	5.0	11.7	16.7	--	--
9. Non-suitability of land	--	5.0	1.7	--	5.0	--	--	--	3.3	1.7
10. Higher cost of ploughing	--	11.7	3.3	--	5.0	--	--	1.7	--	--
11. Low quality feed	--	--	--	--	--	--	--	--	13.3	40.0
12. Lack of drainage facility	1.7	--	25.0	--	--	1.7	1.7	--	13.3	--
13. Ponds need frequent cleaning	--	--	--	--	--	--	--	--	11.7	--
B. Marketing problems										
1. Higher price of fertilizers	46.7	31.7	45.0	5.0	25.0	25.0	45.0	50.0	8.3	3.3
2. Adulteration of fertilizers	1.7	8.3	20.0	5.0	5.0	3.3	8.3	13.3	--	--
3. Higher price of pesticides	18.3	13.3	8.3	18.3	3.3	23.3	8.3	8.3	--	--
4. Higher price of oil and fuel	--	16.7	8.3	1.7	1.7	1.7	5.0	1.7	--	--
5. Higher price of irrigation	--	--	16.7	--	3.3	15.0	3.3	3.3	5.0	--
6. Higher price of inputs (seed, fingerlings & chick)	--	1.7	11.7	--	--	5.0	3.3	--	21.7	20.0
7. Higher price of feed	--	--	--	--	--	--	--	--	40.0	71.7
8. Transportation problem/higher cost	3.3	--	1.7	1.7	3.3	--	21.7	10.0	16.7	15.0
9. Lack of storage	1.7	1.7	3.3	--	--	--	5.0	1.7	--	--
10. Lower price of produces/outputs	5.0	25.0	23.3	1.7	10.0	--	18.3	31.7	11.6	26.7
11. Higher price of vitamins and vaccine	--	--	--	--	--	--	--	--	--	41.7

Table 10.1 Continued

Problems	Banana	Garlic	Maize	Okra	Onion	Patol	Pineapple	Potato	Fish	Poultry
C. Social problems										
1. Scarcity of labour and its higher price	20.0	38.3	33.3	15.0	50.0	26.7	48.3	21.7	21.7	18.3
2. Lack of training	5.0	5.0	1.7	--	--	6.7	5.0	--	3.3	3.3
3. Unrest in the hill	--	--	--	--	--	--	7.0	--	--	--
4. Stealing of fruits	--	--	--	--	--	--	8.0	--	--	--
5. Load shading of electricity	--	--	--	--	--	--	--	--	--	18.3
D. Other problems	--	5.0	5.0	--	1.7	1.7	11.7	--	1.7	3.3

Note: Other problems include weed infestation, inefficient irrigation system, absence of pineapple juice factory, lack of plain land, pineapple could not sale timely, low quality chick, erosion of pond's side, lack of soil test facility, and lack of government assistance.

Lack of drainage facility: Excess water is harmful for any kind of crop production. It is also harmful for fish culture when proper drainage facility is absent. A regular abundant water supply is essential for the maintenance of healthy fish stocks. Water logging for long time is also harmful to crop production. Many maize growers (25%) were facing lack of adequate drainage facility during raining season as a problem, while 13% of the fish growers facing this problem in the study areas.

Ponds need frequent cleaning: A supply of good quality water is essential for fish culture. Poor water quality reduces fish survival and growth. The water supply must be relatively free of nutrients, sewage and other dissolved wastes, heavy metals, oils, pesticides, herbicides, chlorine, methane and other poisonous substances. In order to maintain the water quality ponds need frequent cleaning which involves extra cost. But the marginal fish farmers in the study areas could not manage this money all the time. Almost 12% of the fish growers mentioned it as a problem of fish cultivation.

10.1.2 Marketing problem

Higher price of fertilizers: Fertilizer is one of the most important inputs which provide essential nutrients for plant and increase crop production. The current price of fertilizers is seems to be high to most of the farmers in the study areas. About half of the respondent potato growers mentioned high price of fertilizer as one of their major problems followed by banana (46.7%), maize (45%) and pineapple (45%) growers. Such problem led some of the farmers to apply lower amount of fertilizers which aggravated the imbalance use of fertilizer. This was a common reported problem in the study areas. However, the farmers of Rangpur, Bogra and Tangail mostly faced this problem during cultivation.

Adulteration of fertilizers: Generally, soil provides all the essential nutrients to crop. Agriculture is an intensive cultivation of a particular crop at a particular place, where the soil cannot provide all the essential nutrients to the crops in proper proportion. In most cases, fertilizer application in proper proportions and adequate quantities makes soil fertile. Now a day, farmers are facing adulteration of fertilizer due to its higher price. With the application of such adulterated fertilizers, crops are not getting proper nutrients as a result farmers could not reap better yield and incur monetary loss due to higher cost of production. In the study areas, 20% of the maize growers mentioned it as a problem followed by potato growers (13.3%). This problem was reported most by the farmers of Bogra, Pabna and Tangail district.

Higher price of pesticides: Pesticide is an important input which helps the farmers to reduce the attack of different insect and diseases. But due to higher price of pesticide poor farmers opined not to apply pesticides sufficiently that reduces the yield of the crop. The highest 23.3% of the pointed gourd farmers and 18.3% each of banana and okra farmers encountered this as a problem. This problem was faced by the farmers to some extent.

Higher price of oil and fuel: Oil and fuel are essential for crop production. Farmers of our country generally plough their land by using power tiller or tractor on hire basis. Due to higher price of oil and fuel, farmers need to pay higher amount of money for land preparation. About 17% of the garlic farmers mentioned it as a problem in the study areas.

Higher price of irrigation: The higher price of irrigation was another problem of cultivating different crops. This problem arises mainly due to high price of electricity and disease. About 17% of the maize and 15% of the pointed gourd farmers mentioned higher price of irrigation as

a problem of cultivating these crops. Rangpur and Dinajpur farmer mostly reported this problem to some extent.

Higher price of other inputs (seed, fingerlings & chick): Quality seed is essential for crop farmers, whereas quality fingerlings and chicks are equally important for fish and poultry farmers for higher production. Due to their high prices farmers in the study areas could not buy these inputs in sufficient quantity. This problem is severe in the case of poultry farming. About 12% maize growers also mentioned it as a problem. All the respondent farmers in Chittagong district, 83.3% in Gazipur district and 53.3% farmers in Mymensingh district mentioned the higher price of inputs as a major problem.

Higher price of feed: Feed is one of the important inputs of fish and poultry farming. It is now recognized that feed affects the size and quality of outputs. The importance of selecting the correct diet is the difference between making a profit and loss. But higher price prevent the farmers to buy and use it for higher production. Almost 72% of the poultry farmers mentioned it as a severe problem of their farming, whereas 40% of the fish growers faced this problem during fish farming.

Transportation problem: After harvesting the crops farmers need to sell their produce in the market. Due to lack of proper transportation facilities the farmers cannot bring their product to the market in time. Sometimes they have to pay higher price to bring the product to the market. Transportation problem was severe for pineapple (21.7%), fish (16.7%) and poultry (15%) farmers. This problem is acute in Mymensingh, Rangamati and Chittagong district.

Lack of storage facility: Product price generally remains low at harvesting period. Storage of produces is necessary for getting higher price. Due to lack of storage facility in the study area, farmers could not keep their produce for selling later. Nonetheless, subsistence farmers have to sell their produces just after harvesting due to the need of cash for family and cultivating the next crop. Some of the respondent growers of banana, garlic, maize, pineapple and potato faced this storage problem to some extent in the study areas.

Lower price of outputs: Most of the farmers of our country are small-holders, poor and unorganized. On the other side, existing marketing systems of most agricultural produces is inefficient and dominated by middlemen traders. All these situations make product price low and farmer incurred loss in crop cultivation. This problem was mentioned by many respondent farmers in the study areas. About 32% of the potato farmers, 26.7% poultry farmers and 25% garlic farmers mentioned it as a problem. The farmers of Gazipur, Bogra and Tangail district mostly face the lower price of output as a problem.

Higher price of vitamins and vaccine: Vitamin and vaccine is very important for the growth of poultry. Therefore, poultry farming is not possible without these two elements. The high price of these inputs prevents farmers to use it in an appropriate rate that affect quality poultry production. Fifteen percent of the poultry farmers mentioned it as a problem of growing poultry. More than 53% respondent farmers of Gazipur and 30% farmers of Chittagong district encountered this problem during poultry farming.

10.1.3 Social problem

Scarcity of labour: Human labour is essential for ploughing, sowing, intercultural operation, harvesting, threshing etc in crop production. Non-farm employment opportunity has been created to a large extent and farm labourers in the study areas migrated from agriculture farming to non-farm activities for higher income. Therefore, the scarcity of human labour

along with their higher wage is found in different cropping seasons that ultimately hamper the whole process of cultivation. Most of the crop growers in the study areas mentioned it as a severe problem of cultivation. About half of the respondent onion farmers mentioned that they faced this problem during the growing season. Besides, pineapple (48.3%), garlic (38.3%) and maize (33.3%) growers also faced this problem to a great extent. The highest percentage of farmers of Tangail, Faridpur, Pabna, and Bogra mentioned scarcity of labour as a crucial problem for cultivation.

Lack of training: Due to lack of technical knowledge farmers were using traditional method of cultivation and getting low yield. If proper training on modern technology is arranged for the farmers they can obtain knowledge from the training and can apply on their crop field. About 7% of the pointed growers mentioned the lack of technical knowledge as a problem of growing crop. Growers of banana, garlic, maize, fish and poultry also faced this problem.

Unrest in the hill and stealing of fruits: Pineapple is mainly grown in the hilly areas. A total of 13 indigenous groups (tribal) live in the three hill districts. Due to various socio-economic and political affairs including the establishment of supremacy over other groups create unrest in the hill. Unrest in the hill during pineapple cultivation and harvesting sometimes create major problems for the pineapple farmers. About 7% of the growers faced this problem during growing season.

Pineapple is one of the juicy and delicious fruits of Bangladesh. As a result pineapple growers often faced stealing problem during its ripening period. Eight percent of the pineapple growers mentioned it as a problem in the study areas. Thirty percent pineapple growers in Rangamati district faced these problems.

Load shading of electricity: Electricity is very important for the growth of chickens. It helps to facilitate sight, stimulate internal cycles due to day-length changes and initiate hormone release. But in our country poultry farmers are facing electricity problem to a great extent. More than 18% of the poultry farmers mentioned that load shading was one of their major problems. Thirty percent farmers in Gazipur district reported it as a problem.

10.1.4 Other problems

Beside the aforesaid problems, farmers in the study areas also faced some other problems like weed infestation, inefficient irrigation system, absence of pineapple juice factory, low quality chick, erosion of pond's side etc.

10.2 Constraints to Agricultural Diversification

Non-diversified farmers were asked why they did not cultivate diversified crops in order to know their opinion about the constraints of diversification in the study areas. According to their opinions the following constraints were identified and presented in Table 10.2 and Appendix Table 80.

10.2.1 Lack of suitable land or land far away

Land is the most important factor of production. Without land crop cultivation is not possible. The land provides different essential micro nutrients to different crops. The lack of suitability of land prevents farmers to grow different crop in the same piece of land. Among the non diversified farmers, more than 45% of the farmers mentioned non suitability of land as a constraints of diversification. This is a common problem in the study areas. The highest

percentage of farmers in Pabna, Mymensingh, Dinajpur, and Tangail mentioned this as a problem of not growing diversified crops.

10.2.2 Lack of own and sufficient capital

In most cases, diversified crop cultivation requires larger amount of capital compared to non-diversified crops. But poor farmers of our country do not have enough money for diversified farming. According to the opinion of the farmers, it is the second most important constraints to diversification in the study areas. More than 44% of the non diversified farmers mentioned it as a constraint of diversification. The farmers of Chittagong, Gazipur, Rangamati, and Mymensingh encountered this problem seriously.

10.2.3 Scarcity of labour and its higher price

Human labour is important to perform different types of intercultural operations. Diversified farming required more human labour to perform this function. Now a day, people are migrating from rural to urban areas for better employment opportunities. As a result farmer in the study areas, facing shortage of labour and hiring them with high wage rate. More than 26% of the non diversified farmers identified it as a constraint of diversification. It was a common problem found in the study areas. However, the farmers of Tangail, Faridpur and Pabna reported this problem higher than other study areas.

Table 10.2 Constraints to agricultural diversification in the study areas

Constraints	Respondent (<i>N</i> = 360)	Percent of responses
1. Lack of suitable land/land far away	163	45.3
2. Lack of own and sufficient capital	159	44.2
3. Scarcity of labour and its higher price	95	26.4
4. Higher cost of production	89	24.7
5. Lack of fair price of the produces	63	17.5
6. Lack of training facility	33	9.2
7. Infestation of insects and diseases	32	8.9
8. Higher price of fertilizers	30	8.3
9. Required higher labour	29	8.1
10. Lack of HYV seed/seedling/check	26	7.2
11. Lack of short duration crop	14	3.9
12. High risk in production (bird flu, etc)	14	3.9
13. Lack of irrigation facility	12	3.3
14. Higher price of seed/seedling/feed/cheek	11	3.1
15. Natural calamities (drought, rainfall, storm, kuasa)	6	1.7
16. Lack of credit facility	5	1.4
17. Lack of transport facility	5	1.4
18. Load shading of electricity	4	1.1
19. Others	14	3.9

Note: Other constraints include low yield, lack of juice factory, lack of storage facility, low quality poultry medicine, adulteration of fertilizer, lack drainage facility, cultivation of other crops, etc.

10.2.4 Higher cost of production

Cultivation of diversified crops involves higher cost of production due to different types of managerial and intercultural operations. Besides, the prices of most production inputs have been increased to some extent. As a result the cost of crop production is increased to a greater extent. About 25% of the non diversified farmers mentioned that higher cost of production is one of the major constraints of diversification. This problem was importantly mentioned by the farmers of Pabna, Rangamati and Bogra district.

10.2.5 Lack of fair price of products

Most of the farmers of our country sell their produces at lower price immediately after harvesting. Besides, poor farmers of our country are unorganized and have low bargaining power as a result they get lower price of their produces. More than 17% of the non diversified farmers in the study areas mentioned lack of fair price as a constraint of diversification. Bogra, Faridpur and Rangpur farmers reported this problem more seriously than the farmers of other study areas.

10.2.6 Lack of training facility

Knowledge is a powerful tool to increase production of any crop. Most diversified farming required technical knowledge about the modern technology of cultivation. Short-term hand-on training programme can play a vital role to increase the knowledge of the farmers about the modern technology of cultivation. But due to lack of training facilities in the study areas farmers are not able to gather proper knowledge about modern cultivation practices. More than 9% of the non diversified farmers mentioned lack of training facilities as a constraint of cultivating diversified crop. A good number of farmers in Mymensingh and Chittagong reported it as a problem.

10.2.7 Infestation of insects and diseases

Diversified farming means growing more crops other than cereals by a farmer which increases the chances of insect and diseases infestation. Therefore, the sustainability of crop yield is being threatened. About 9% of the non diversified farmers mentioned it as a reason for not cultivating diversified crops. It was highly mentioned by the farmers of Kustia and Jessore districts.

10.2.8 Higher price of fertilizers

Plants generally take essential micro nutrients from the soil. Due to low soil fertility, sometimes plants are unable to uptake proper nutrients from the soil. To overcome this problem farmer need to apply proper amount of fertilizer in the crop field. But higher prices of the fertilizers prevent them to do so. In the study areas, 8.3% of the farmers opined that due to higher price of fertilizers they cannot cultivate diversified crops.

10.2.9 Required higher labour

The higher amount of labour is essential for performing different crop management practices for diversified crop cultivation. The poor farmers of our country cannot afford to meet this extra requirement of labour. In the study areas, 8.1% of the farmers mentioned that due to higher labour requirement they cannot cultivate diversified crops. Twenty percent farmers of each Gazipur, Pabna and Rangamati district reported that they did not cultivate diversified crops due to its labour intensiveness.

10.2.10 Lack of HYV seed/seedling/chick

The high yielding varieties of seed/seedling and chick are still not available to all the areas of Bangladesh. Many farmers are still using traditional variety of seed/seedling of diversified crops and getting lower yield and financial return. Again, many poultry farms are facing the

lack of quality chicks in the study areas. Therefore, 7.2% of the non-diversified farmers are not interested to grow diversified crops in their field due to lack of high yielding varieties of crops. The highest number of farmers in Rangpur district reported this problem.

10.2.11 Lack of short duration crop

Most of the crop varieties of our country required more days to mature. Farmers are unable to fit these crops with their desired cropping pattern. As a result they are not interested to cultivate diversified crops in their field. About 4% of the non diversified farmers in the study areas mentioned it as a constraint of diversification.

10.2.12 High risk in production

Agricultural production associated with different types of risks like flood, drought, attack of insects and diseases, bird flu (for poultry), etc. In the recent past bird flu drastically reduced the production of poultry. According to the opinion of poultry farmers a total of 25,000 farms were wiped out due to bird flu in the last one year (Parvez, 2012). Therefore, about 4% of the poultry farmers in Chittagong and Gazipur mentioned that higher risk in production restricts them to adopt poultry farming.

10.2.13 Lack of irrigation facility

Although most of the lands of our country are under irrigation facility, some lands are not getting irrigation facility due to long distance from the irrigation sources. They irrigated their land manually. As a result these land owners are not interested in diversified farming. More than 3% of the farmers mentioned it as a constraint of diversification in the study areas. This problem was reported from most of the study areas except Bogra, Chittagong, Kustia and Jessore districts.

10.2.14 Higher price of seed/seedling/feed/chick

Quality seed/seedling/chick and feed is essential for higher production. But the higher prices of these quality inputs often limit the poor farmers to buy the desired quantity. Among the non diversified farmers, 3.1% mentioned higher price of seed or feed as a limiting factor for diversification in the study areas. Gazipur farmers mostly mentioned this problem.

10.2.15 Natural calamities

The problems of natural calamities like drought, rainfall, storm etc were mentioned by 1.7% of the non diversified farmers as a constraint of diversification.

10.2.16 Lack of credit facility

The farmers often do not have the access of credit facility from nationalized banks due to different formalities. As diversified farming requires large amount of capital the poor farmers cannot cultivate diversified crops in the field. On an average 1.4% of the non diversified farmers mentioned lack of credit facility as a constraint of diversification. More than 13% of the responded farmers of Chittagong district raised this problem for not cultivating diversified crops.

10.2.17 Lack of transport facility

Among the non diversified farmers, about 1.4% mentioned that lack of transportation facilities to carry the produce to the market as a limitation of diversification.

10.2.18 Load shading of electricity

Electricity is particularly important for the growth of chicks as well as for irrigation. Due to electricity problem growth of chicks are seriously hampered. Farmers also cannot provide timely irrigation to the crops. As a result they received lower yield. About 1.1% of the farmers opined load shading as a constraints of diversification in the study areas. The poultry farmers of Chittagong and Gazipur district mentioned this problem.

10.2.19 Other problems

There are some other constraints such as low yield, lack of juice factory, and low quality poultry medicine which mentioned by the farmers as constraints of diversification in the study areas.

10.3 Facility Needed to Accelerate Agricultural Diversification

The non-diversified respondent farmers in the study areas were asked to mention the facilities they needed to produce diversified commodities. Their opinions have been presented in Table 10.3 and Appendix Table 81.

10.3.1 Required availability of land resources

Most of the farmers of our country are small and they have very small quantity of land. They cannot produce diversified commodities in their small pieces land. Besides, all the lands are not suitable for all kind of crops. More than 31% of the non diversified farmers mentioned that if they can manage suitable lands through leasing or share cropping basis, they will cultivate diversified commodities in future. The highest percentage of farmers from Mymensingh, Pabna, Dinajpur and Bogra mentioned this for accelerating agricultural diversification in the study areas.

10.3.2 Required financial assistance/cash subsidy

Diversified crop cultivation requires different inputs like fertilizer, irrigation in higher quantity. The poor farmers cannot avail these inputs at all the time when required. About 30% of the non diversified farmers mentioned that if government can provide financial assistance like cash subsidy to buy necessary inputs such as fertilizer or irrigation which will help them to adopt diversified farming. The highest percentage (56.7%) of farmers from Rangamati district demanded financial assistance from government followed by the farmers of Gazipur (43.3%) and Pabna (40%) district.

10.3.3 Required credit with low interest rate

Framers need liquid money at the time of cultivation. They often borrow money from informal sources of credit with high interest rate to meet the financial requirement. More than 27% of the farmers mentioned that government should take necessary steps to make institutional credit facilities available and easy to the farmers at low interest rate. Half of the respondent farmers of Gazipur district and 43.3% farmers each from Chittagong and Rangpur district required agricultural credit from commercial banks with low-interest rate for producing diversified commodities in future.

10.3.4 Ensure availability and lower prices of inputs

Good quality seed, fertilizers, pesticides are important inputs for producing different crops. Price of these important inputs is higher for the poor farmers of our country. Besides, farmers

often have to buy adulterate fertilizer and pesticides from the market. More than 18% of the non diversified farmers opined that government should take necessary steps to supply the inputs at subsidized rate and also take necessary steps against adulteration to speed up diversified farming. This problem was commonly reported from all the study areas. However, 40% of the respondent farmers from Faridpur and Rangpur district suggested ensuring the availability of inputs along with their lower prices to accelerate agricultural diversification in Bangladesh.

Table 10.3 Facilities demanded for producing diversified commodities

Facility demanded	Respondent (<i>N</i> = 360)	Percent of responses
1. Required availability of land resources	113	31.4
2. Required financial assistance/cash subsidy	104	28.9
3. Required credit with low interest rate	98	27.2
4. Ensure availability and lower prices of inputs (fertilizer, seed, pesticides, feed, chick, etc.)	66	18.3
5. Required HYV and short durated crop seed	69	19.2
6. Ensure fair price of the produces	65	18.1
7. Provide hand on training facility	40	11.1
8. Ensure labour availability and reduces its price	32	8.9
9. Ensure lower price of oil and fuel	15	4.2
10. Provide adequate irrigation facility	10	2.8
11. Develop better transportation system	3	0.8
12. Ensure uninterrupted electricity supply	5	1.4
13. Others	8	2.2

Note: Other facilities include control middlemen' ***, ensure drainage facility, ensures vaccination, establishes pineapple juice factory, establish storage facility, etc.

10.3.5 Required HYV and short-duration crop seed

Farmers of our country use traditional variety of seed in their field. As a result they received lower yield. More than 19% of the non diversified farmers mentioned that they need HYV seed of diversified commodities as well as seed of short duration crops so that they can fit these crops in their desired cropping pattern. The higher number of farmers of Rangpur and Bogra required HYV crops with early maturing character for accelerating agricultural diversification in the study areas.

10.3.6 Ensure fair price of the produces

Product price is an important item to the farmers for cultivating that crop. Farmers often do not get fair price of their produces. About 18.1% of the farmers suggested that government should take necessary action like fixing of harvesting price to ensure fair price of the produce which will help the farmers to adopt diversified farming. Ensuring fair price of the produces was emphasized by 47% farmers in Bogra, 37% in Faridpur and 30% in Rangpur district.

10.3.7 Provide hand-on training

Training is an important tool to enhance knowledge and skill. More than 11% of the farmers approached for providing training on different aspect of crop management technology to ensure diversified farming in the study areas. Concern authorities along with local agricultural officers can play a vital role in providing short term training to the farmers. The need of

training was raised by the respondent farmers of all the study areas to some extent. However, the higher percentage of farmers from Chittagong and Mymensingh demanded this need to expedite agricultural diversification in the study areas.

10.3.8 Ensure labour availability and reduces its price

Availability of labour is crucial to perform the different type of crop management activities during the growing season. About 9% of the non-diversified farmers mentioned that the availability of farm labour with low price can play an imperative role in attaining agricultural diversification in the study areas. However, this problem can be solved to a large extent by introducing farm mechanization in agricultural production.

10.4.9 Ensure lower price of oil and fuel

Oil and fuel is important input to run shallow tube well for irrigation as well as for power tiller or tractor for ploughing. Higher price of oil and fuel means higher production cost and lower return. If the government can ensure lower price of oil and fuel the farmers will get more return and can invest it in further production. More than 4% of the farmers opined that lower price of oil and fuel is essential for diversification in the study areas. The higher number of Faridpur farmers suggested ensuring the lower price of oil and fuel to accelerate agricultural diversification.

10.3.10 Provide adequate irrigation facility

According to the 2.8% of the non diversified farmers that adequate irrigation facilities to their land is essential to adopt diversified farming. Ten percent farmers each from Rangpur, Dinajpur and Rangamati district requested government for providing adequate irrigation facility for them.

10.3.11 Develop better transportation system

In the study areas farmers face problem in marketing their produces due to lack of transportation facilities. With better transportation facilities farmers can move their produces from one market to another for better price. About 0.8% of the farmers mentioned that better transportation facilities are the prerequisite for diversification. Village roads should be developed so that rickshaws or motor vehicles could move easily.

10.3.12 Ensure uninterrupted electricity supply

Electricity is vital for poultry as well as for irrigation. Among the non diversified farmers 1.4% mentioned that continuous supply of electricity is crucial to enhance the agricultural diversification in the study areas.

10.3.13 Other facilities

Farmers in the study areas also demanded some other facilities like control of middleman's, create adequate drainage facility, establish pineapple juice factory, establish storage facility, etc to ensure agricultural diversification.

CONCLUSION AND POLICY RECOMMENDATIONS

11.1 Summary and Conclusions

This study analyzes agricultural data for 23 old districts and survey data from 960 diversified and non-diversified farmers to understand the pathway of change to understand the gradual shift of Bangladesh agriculture from a mostly subsistence farming practices to some degree of commercialization. Agricultural diversification is defined to be diversification into non-cereal agriculture (including fisheries, poultry and livestock). There were two aspect of our analysis: a) understanding of non-cereal diversification from a macro and policy perspective and b) understanding of non-cereal diversification (defined as agricultural diversification) from farmer's perspective.

The study used historical data and past studies to understand the impact of crop diversification program (CDP). Among the field crops, agricultural diversification has been very low but, there were positive impacts of the CDP on the production of tubers, oilseeds and pulses. The production of these crops increased in those areas under the programmes as compared to the non-CDP areas. The level of crop diversity actually increased by 4.5% over the 36-year period from 1960 to 1996, when the two agricultural censuses were conducted. Each CDP crop experienced a different set of problems. However, the Ministry of Agriculture (2000) identified some common constraints for promoting crop diversification: These constraints were non-availability of suitable land; non-availability of water and technology packages; low adoption rate of new varieties; imports of pulses and edible oils as disincentives to diversification; and lower price of CDP crops.

Analysis of financial feasibility results found most agricultural commodities to be profitable both in financial and economic point of view. However, in terms of financial profitability perennial fruit production are found to be the best, followed by oilseeds and spices, non-cereal crops, and fisheries. Rice and wheat happened to be among the least profitable crops in agriculture.

Analysis of area, yield and production growth reveals that maize, potato, pointed gourd, okra, onion, garlic, and mango had impressive growth rates both in area and production during 1990-2009. Although the growth rates of area and production of pulse crops are negative, the growth rates of yields are positive due to adoption of improved varieties. Comparative growth scenario shows that performance of maize, oilseeds, vegetables, potato, mango and fish were found to be better in Bangladesh compared to India and Pakistan during the same period of time.

With such an impressive performance of our agriculture, it is expected that there would be changes in the per capita consumption of food. Our study used both BBS and HIES data to show changes in the per capita availability and consumption. Significant changes took place in terms of per capita consumption (PCC) of major food items in Bangladesh due to improvement in income, better standard of living, and changing demand pattern for horticultural and livestock products.

At the same time, share of rice in total food basket decreased while that of wheat increased between 2000 and 2010. Sharp increase has been taken place in the PCC of potato, edible oil, onion, chicken, egg, fish, milk and fruits both in rural and urban areas during 2000-2010.

Again, the PCC of vegetables and meat has been increased in rural and urban areas respectively. The overall consumption of non-poor people is 24.5% higher than poor people. The PCC of livestock products, fruits and fish of non-poor households are higher (46-87%) than poor people. The consumption differences are less in rice, potato, and vegetables between two groups. Finally, the level of consumption of different food items remains below the desired level for all categories of households which is important for healthy and productive life.

The agricultural diversification index (ADI) value measure in terms of non-cereal production grew from 51% to 58% over the period of 1993-2010. The changes in ADI show a lot of volatility between years although the trend is positive. Regionally, the highest value of the index was from Chittagong and Barisal and lowest is from Rangpur and Rajshahi.

In terms of South Asian performance, the agricultural diversity index value for Bangladesh is 38% lower than Pakistan and 9% lower than India. This shows that despite many efforts Bangladesh agriculture is still less diversified than that of Pakistan and India. There is, therefore remains a immense scope for diversification of Bangladesh agriculture.

This study used both macro and micro analysis of diversification using secondary and primary data to understand the regional disparity of the index value in Bangladesh. A regression model using panel data by districts shows that real labour wage, per capita road length, rainfall, agricultural credit disbursement, and population (proxy for market size) affects the level of agricultural diversification in Bangladesh. Therefore, it appears that higher real wages promote non-crop diversification. Similarly, higher kilometer of road per person (used to proxy market access) also affects non-cereal diversity of agriculture in Bangladesh. In addition, agricultural credits also promote diversification of agriculture.

On the other hand, farm level data from 960 farmers were analyzed using a probit model and it shows that diversity at the farm level is affected by availability of irrigated land to the farmers –the irrigated land owners are more diversified than non-irrigated farmers, agricultural training – farmers with training are more diversified than farmers without training, extension linkage – farmers with more contacts with agricultural extension office/workers are more diversified than without such contacts, family influence–farmers with positive attitude towards farming are more diversified than without a positive attitude, and farmers with access to credit facility are more diversified than without access to credit. At the same time, access to storage facilities is not so important for farmers to be diversified. This coefficient was not significant. Similarly, access to market is more of a macro phenomenon rather than a micro phenomenon. At the micro level access to market is not important (that is why of the two farmers living in the same locality one may be diversified and one may not).

Both micro and macro analysis of diversification points that there are crucial factors for promoting non-cereal diversification in Bangladesh agriculture. Macro characteristics of the region explain why a region is more diversified while micro characteristics of the farmers explain why a farmer is more diversified. In terms of regional variation of diversity, credit distribution, access to market (used road network as an instrument), real wage rate and the market size (used population of the district as a proxy) are important factors influencing overall regional diversity of agriculture.

Evidences suggest that agriculture diversity has increased in Bangladesh (although slightly) over the period 1990-2010, but HIES data also shows that there has been a change in the pattern of consumption of agricultural commodities in Bangladesh (between 2000 and 2010). Given this, it is possible that there is a trade impact – meaning it might influence the overall trade surplus/deficit of agricultural commodities.

Analysis of net trade shows that except vegetables, Bangladesh is a net importer of most food commodities including wheat, maize (considered as feed), pulses and edible oils. The balance of agricultural trade and food trade in Bangladesh remains negative year after year and it has been increasing steadily in the last decade. This implies that despite increase in production, the overall consumption pressure has led to more imports and so agricultural diversity did not succeed in influencing the trade diversification in case of Bangladesh. Pakistan's scenario is little bit similar to Bangladesh, but India's balance of trade for both agriculture and food are mostly positive.

Farm level data shows that non-diversified farmers have been facing a set of constraints to diversification. These are based on their perception and the list is divided into: a) constraints related to production, and b) constraints related to marketing. The production related constraints include non availability of suitable land; lack of capital; lack of HYV seed/seedlings/chick/fry; shortage of agricultural labour; pest and disease attacks ; lack of irrigation facility; and growing cost of production. On the marketing side, constraints are price fluctuations, high price of inputs; lack of transport facility; and lack of credit. The lack of training facility and load shedding of electricity are also related constraints.

Despite higher production of rice, consumption decreased over time mainly due to changes in food habit. Increased production and decreased per capita consumption might lead to export rice in some years. Profitability in production of rice is very low and so we have seen growth of alternative crops – mainly maize where steady growth of demand was observed from the poultry producers. Wheat also showed a decreasing trend in BCR. Since food prices are often regulated by the government using open market sales, there has been a low risk of production of these items but the rate of profit is low. On the other hand, maize prices are not regulated (since it is not a food item) and so its profitability has been rising. As a result, maize cultivation is on the rise in Bangladesh.

Potato cultivation is largely considered to be a vegetable item in Bangladesh. The high BCR enticed the farmers toward more potato production for a long period. The BCRs of other vegetables cultivation are also on the high-side for which both area and production have been increasing in the country. The increased production of vegetables led to increased per capita availability and consumption of vegetables in Bangladesh. Finally, increased vegetable price contributed greatly to increase in the agricultural diversification of Bangladesh.

The impressive BCR of fruit cultivation keeps farmers' interest to produce more fruit in the country. Despite this, fruit demand is growing in the domestic market and some fruits are imported every year. Therefore, it led to increase in per capita fruit consumption in Bangladesh. Increased domestic production and incentive price of fruits largely contributed to increase agricultural diversification.

The decreased local production of pulses led to increase in import. Though pulse import is on the rise, it is still considered a product in which Bangladesh does not have a comparative advantage. Mustard cultivation covered about 75% of total oilseed areas. Its production remained almost stable (decreased very slightly) over time. Local mustard production could not meet up country's demand and since its value is higher than soybean and palm oil, Bangladesh exported mustard and imported soybean and palm oil to meet the growing demand for edible oil. Per capita availability and consumption of edible oil in Bangladesh has been increasing steadily

Spices especially garlic, onion, chili, ginger and turmeric production increased due to incentives provided by the government in terms of interest on credits and due to rising prices. Yet local production is not sufficient to fulfill the demand for spices. Hence, the country is also importing a huge amount of spices every year. Growth in local production and higher import of spices contributed to increase both per capita availability and consumption of spices.

11.2 Policy Recommendations

This research has studied agricultural diversification from several view points. Firstly, diversification is used to mean non-cereal diversification. This is mainly due to fact that 80% of our agricultural production is cereal. Diversification is also meant to include production of non-crop products like fish, poultry and livestock. In analyzing the diversification of our agriculture, it has been shown that despite several positive efforts, incentives, promotions, the rate of diversification is much lower than India and Pakistan. This signals the difficulty attached to increasing the rate of diversification of our agriculture.

Market pressure through increased demand for non-cereal products from agriculture is there, prices of many of the non-cereal products are on the rise, imports are on the rise and yet the degree of achievement in diversification is low.

Micro and macro assessment of diversification reveals some intriguing stories. Based on these assessments and based on the field observations, the following recommendations are summarized.

11.2.1 Reorganizing the Department of Agricultural Extension (DAE)

There shall be a change in the institution of extension services in Bangladesh. Farmers with more extension contacts are found to be more diversified than others and so it is important that the DAE needs to reorganize itself to ensure more contacts. DAE also needs to re-orient its extension workers to support growing extension needs for non-cereal agricultural products like spices, fruits, vegetables, poultry, fisheries and livestock.

11.2.2 Facilitate agricultural credit to farmers

An agricultural credit is an important factor for diversification of agriculture. Farmers with access to credit facilities are found to be more diversified than others. This is an important finding of this study. This means credit facilities need to be extended to farmers. The current government, for the first time, ensured that farmers have a bank account in a bank in order to facilitate payment of subsidy to them. While the endeavor is a great one its outreach is very limited. In addition, farmers do not receive banking services like other normal customers of the bank. This limits their ability to use banks as the right tool to do transactions. Given the access to mobile networks, government should extend BKASH or mobile banking services to farmers to access credits.

11.2.3 Investment in transportation networks

Access to market is found to be less important at the farmers' level but it is important for increasing diversity in agriculture regionally. This means, a district with better communication and transportation facilities are more diversified than other regions. Most of the non-cereal produces are perishable items and so means of transportation and access to the market is important for them. Ironically, storage at the local level was not found to be an important variable. This is due to the fact that when access to roads is ensured, storage facilities become

less important and it can be provided through private investment. Therefore, investments in public transportation of vegetables, fruits, etc. are important elements to promote agricultural diversification.

11.2.4 Training for farmers

Modern agricultural is much more challenging than before. There are elements of production, processing, storage and transportation and in all of them training is an important pre-condition for ensure higher profit to a farmer. Training includes: a) training in production technologies, b) training in harvesting technologies, c) training in processing and storages, and d) training in packaging for transportation.

In order to promote non-cereal diversification in agriculture, DAE should organize itself to ensure farmers' level training programs – or farmers' summer school instead of concentrating only on IPM technologies.

11.2.5 Irrigation infrastructure for non-cereal producing farmers

In the 1970s investment in irrigation infrastructure lead to green revolution in terms of cereal production. Trends in demand suggest that demand for fruits, vegetables, spices, edible oil, meat and fish are on the rise both for poor and non-poor households. This means a new generation of investment in irrigation technology which will meet needs of the future non-cereal farming population. This means switching towards drip-irrigation, piped-irrigation, instead of promoting the current flood irrigation techniques.

Access to better irrigation technology will not only reduce water requirement for agriculture, it will also allow farmers to choose crops other than rice and wheat. The new generation irrigation technology should be less labor intensive.

11.2.6 Promoting better access to market

Maize production has been growing at a very fast rate in Bangladesh and it is mainly due to ready market for its output. This is due to the fact that poultry producers are many and spread-out throughout the country. The market is not manipulated, or influenced by non-market forces. As a result farmers enjoy higher profitability. Similarly it is true for fruits and vegetable markets. It is, therefore, important that government regulation towards market shall be limited to incentives.

At the same time, each layer of the market-chain should be free from manipulation by their agents and so access to markets by the farmers through 'farmers market', village hut, be ensured. Once the direct entry into the market is cut-off through regulation of market players like who can enter in a market and who cannot often reduces profitability. Therefore, farmers should be given an inherent right to sell their products directly to the customers and for this government should develop markets only for them at a local level. The concept of 'village hut' that used to run twice a week could be introduced in all small townships where sellers must be a farmer.

11.2.7 Risk reduction strategy

Price uncertainties in input and output are a potential threat against farmers moving out of cereal crops. These uncertainties shall be dealt with. There are several strategies for this: a) certification of products and seeds; b) quality assurance of inputs; c) development of liability

rules for failures due to low quality input; d) government procurement rule with known principle of price; and e) supply of credits with reduced interest or other inputs at reduced prices. Government should analyze these policies and develop a comprehensive strategy to induce diversification of agriculture.

11.2.8 Institutional reforms

Diversification of agriculture means both crop and non-crop agricultural production. At the moment the DAE is completely separate from other departments like livestock, fisheries and poultry extension services. All these services are not equally accessible in every region of the country. As such agricultural diversity cannot speed up. Farmers need a one stop service for all. This requires a complete re-thinking of our current DAE.

11.2.9 Development of new technologies

Most farmers cannot harvest the benefit of diversification due to low yield of diversified commodities which is the result of cultivating local cultivar of these commodities. In order to promote the diversification with diversified commodities, investment should be directed to reduce yield fluctuation by developing improved technologies including new variety, off-season variety, stress-tolerant and resistant varieties of these crops. The national agricultural research institutes should make efforts to develop improved varieties and production systems with comparative advantage, of fruits, vegetables, spices, livestock, poultry and fish to open up new opportunities for farmers.

11.2.10 Encourage farm mechanization

The shortage of farm labourer is currently a common phenomenon in agriculture due to the expansion of non-farm employment opportunities with higher wage throughout the country. It creates various problems in the process of production and marketing of diversified crops. Therefore, farm mechanization should be encouraged in various agricultural activities for combating the impending labour shortages, minimizing the cost of production, reducing the turn over period of cultivation, augmenting farmers' income, and conserving natural resources.

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APPENDIX TABLES

Table 1. Contribution of different sub-sectors of agriculture to GDP at constant market price (Base year: 1995-96=100)

Sector/ Sub-sector	<i>(In percentage)</i>									
	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10*
Agriculture	25.02	23.98	23.47	23.08	22.27	21.84	21.37	20.83	20.49	20.16
i. Crop	14.70	13.75	13.43	13.32	12.51	12.28	12.00	11.64	11.43	11.23
ii. Livestock	2.95	2.96	2.93	2.91	2.95	2.92	2.88	2.79	2.73	2.67
iii. Forestry	1.87	1.88	1.86	1.83	1.82	1.79	1.76	1.75	1.75	1.75
iv. Fisheries	5.51	5.40	5.25	5.11	5.00	4.86	4.73	4.65	4.58	4.51

Source: Bangladesh Economic Review, 2010. *Provisional

Table 2. Annual growth rates of GDP of agriculture and its sub-sectors at constant market price (Base year: 1995-96=100)

Sector/Sub-sector	<i>(In percentage)</i>									
	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10*
GDP	5.27	4.42	5.26	6.27	5.96	6.63	6.43	6.19	5.74	6.00
Agriculture	5.5	-0.6	3.29	4.38	1.80	5.23	4.69	2.93	4.10	4.36
i. Crop	6.2	-2.4	2.88	4.27	0.15	5.03	4.43	2.67	4.02	4.22
ii. Livestock	2.8	4.7	4.51	4.98	7.23	6.15	5.49	2.44	3.48	3.98
iii. Forestry	4.9	4.9	4.43	4.18	5.09	5.18	5.24	5.47	5.69	5.89
iv. Fisheries	-4.5	2.2	2.33	3.09	3.65	3.91	4.07	4.18	4.16	4.50

Source: Bangladesh Economic Review, 2010. *Provisional

Table 3. Annual growth rates of different crops and non-crops enterprises, 1995-2009

Sl. no.	Crop	Area ('000' ha)	Production ('000' MT)	Sl. no.	Crop	Area ('000' ha)	Production ('000' MT)
1	Rice	0.59%	4.10%	12	Mustard	-3.70%	-1.80%
2	Maize	2.16%	2.98%	13	Onion	11.12%	16.02%
3	Jute	-1.90%	-0.40%	14	Garlic	8.50%	11.63%
4	Tobacco	-1.10%	0.79%	15	Chili	4.64%	8.23%
5	Okra	5.65%	7.48%	16	Banana	3.11%	3.43%
6	Bitter gourd	3.91%	5.19%	17	Pineapple	1.78%	4.20%
7	Pointed gourd	5.98%	8.54%	18	Mango	-4.80%	12.90%
8	Eggplant	2.95%	3.53%	19	Jackfruit	-9.20%	11.84%
9	Cauliflower	4.06%	5.78%	20	Culture fish	3.27%	7.87%
10	Radish	1.81%	2.21%	21	Poultry meat	--	16.41%
11	Potato	8.34%	11.39%				

Source: Calculated using BBS data

Table 4. Profitability of modern *Aus* paddy cultivation in Bangladesh, 2004-2010

Year	Yield (t/ha)	Sale price (Tk/ton)	At nominal price (Tk/ha)			At real price (Tk/ha)			BCR
			Total cost	Gross return	Net return	Total cost	Gross return	Net return	
2004	3.535	8050	22271	30596	8325	3204797	4402764	1197968	1.37
2005	3.372	8800	26707	32033	5326	4092314	4908417	816103	1.20
2006	3.757	8870	33078	35858	2780	5431738	5888242	456504	1.08
2007	3.735	10920	36963	43527	6564	6507706	7663364	1155658	1.18
2008	4.270	14870	55015	66088	11073	10647603	12790672	2143068	1.20
2009	4.089	12500	53180	54440	1260	10977947	11238049	260102	1.02
2010	3.385	18750	68027	68355	328	15070021	15142683	72662	1.00
GR (%)	1.37ns	13.41***	18.70***	14.58***	-40.01*	26.03***	21.92***	-32.67ns	--

Note: '*', '**' and '***' represent significant at 10%, 5% and 1% level respectively

ns = Not significant; Gross return includes the value of bi-product (straw)

Source: BIRRI (2004-2010)

Table 5. Profitability of modern *Aman* paddy cultivation in Bangladesh, 2004-2010

Year	Yield (t/ha)	Sale price (Tk/ton)	At nominal price (Tk/ha)			At real price (Tk/ha)			BCR
			Total cost	Gross return	Net return	Total cost	Gross return	Net return	
2004	4.310	7600	21609	38308	16699	3109535	5512521	2402986	1.77
2005	3.765	9370	27948	35221	7273	4282472	5396914	1114442	1.26
2006	4.105	10710	29739	46810	17071	4883441	7686670	2803229	1.57
2007	4.040	15000	50617	64253	13636	8911629	11312383	2400754	1.27
2008	4.037	16250	59385	72068	12683	11493373	13948041	2454668	1.21
2009	3.647	15000	48349	58062	9713	9980684	11985739	2005055	1.20
2010	4.064	18750	64808	79342	14534	14356916	17576633	3219717	1.22
GR (%)	-0.92ns	14.53***	18.15***	12.91***	-0.48ns	25.49***	20.25***	6.86ns	--

Note: '***' represents significant at 1% level, ns = Not significant

Gross return includes the value of bi-product (straw)

Source: BIRRI (2004-2010)

Table 6. Profitability of modern *Boro* paddy cultivation in Bangladesh, 2004-2010

Year	Yield (t/ha)	Sale price (Tk/ton)	At nominal price (Tk/ha)			At real price (Tk/ha)			BCR
			Total cost	Gross return	Net return	Total cost	Gross return	Net return	
2004	4.962	7490	28249	35719	7470	4065031	5139964	1074933	1.26
2005	5.201	8310	36200	46007	9807	5546926	7049653	1502727	1.27
2006	5.453	8660	40019	49797	9778	6571520	8177165	1605645	1.24
2007	5.818	17470	75596	114135	38539	13309432	20094608	6785176	1.51
2008	5.038	12500	68553	71991	3438	13267748	13933138	665391	1.05
2009	5.533	15000	70397	87637	17240	14532053	18090906	3558853	1.24
2010	5.415	17500	95081	100379	5298	21063294	22236960	1173666	1.06
GR (%)	1.10ns	14.62**	19.68***	16.99**	-3.38ns	27.01***	24.33***	3.95ns	2.62ns

Note: '**' and '***' represent significant at 5% and 1% level respectively; ns = Not significant

Gross return includes the value of bi-product (straw)

Source: BIRRI (2004-2010)

Table 7. Profitability of modern variety wheat production in Bangladesh, 2004-2009

Year	Yield (t/ha)	Sale price (Tk/ton)	At nominal price (Tk/ha)			At real price (Tk/ha)			BCR
			Total cost	Gross return	Net return	Total cost	Gross return	Net return	
2004	2.237	11500	15258	27936	12678	2195626	4019990	1824364	1.83
2005	1.984	12500	16836	27228	10392	2579780	4172146	1592366	1.62
2006	1.690	14560	18458	26915	8457	3030988	4419712	1388724	1.46
2007	2.280	19050	19032	46118	27086	3350774	8119535	4768761	2.42
2008	2.530	15030	22634	40864	18230	4380584	7908819	3528234	1.81
2009	2.650	15560	29468	43636	14168	6083079	9007779	2924700	1.48
GR (%)	5.36ns	6.67ns	12.03***	11.39**	9.73ns	19.38***	18.75***	17.09ns	--

Note: '**' and '***' represent significant at 5% and 1% level respectively; ns = Not significant

Gross return includes the value of bi-product (straw)

Source: BARI (2004-2009)

Table 8. Financial profitability of hybrid maize production in Bangladesh

Particulars	Cultivation year					
	2006	2007*	2008 ^a	2008 ^b	2009	2010
Yield (t/ha)	7.48	3.11	6.27	5.51	8.00	7.75
Sale price (Tk/kg)	7.89	38.00	8.71	13.0	8.58	7.60
Gross return (Tk/ha)	60545	120132	60981	72276	69773	60412
Grain	59026	118180	54613	70725	68628	58889
Stover	1519	1952	6368	1552	1145	1523
Total cost (Tk/ha)	28209	63558	27240	31970	44197	31956
Net return (Tk/ha)	31336	56574	33741	40306	25575	28456
Benefit cost ratio	2.15	1.99	2.24	2.26	1.58	1.89

Source: Islam et al. (2006); Haque et al. (2007); Hasan (2008a); Uddin (2008b); Moniruzzaman et al. (2009); Karim et al. (2010). *Profitability of hybrid maize seed production.

Table 9. Profitability of jute cultivation in different districts

Particular	Rangpur	Faridpur	Rajbari	Jessore	Mean
Fiber yield (kg/ha)	1893	2252	3010	2936	2523
Jute stick yield (kg/ha)	4259	5067	6773	6606	5676
Price of fiber (Tk/kg)	21.43	25.45	24.11	20.09	22.77
Price of jute stick (Tk/kg)	2.00	2.00	2.00	2.00	2.00
Total Returns	49085	67447	86117	72196	68712
Fiber	40567	57313	72571	58984	57359
Jute stick	8518	10134	13546	13212	11353
Total costs	32745	42853	37987	43322	39227
Net returns	16340	24594	48130	28874	29485
Rate or return (BCR)	1.50	1.57	2.27	1.67	1.75

Source: BJRI (2008)

Table 10. Financial profitability of lentil production in Bangladesh

Items	Cultivation year					
	2000	2004	2005a	2005b	2010	2012
Grain yield (kg/ha)	659	700	985	869	949.53	1733
Price (Tk/kg)	18.00	25.02	23.44	23.96	39.66	45.63
Total Returns	12271	17516	24099	21442	39773	80572
Grain	11862	15492	23092	20829	37644	79072
Stover	409	2024	1007	613	2129	1500
Total costs	5559	9719	15991	14073	17598	52734
Net returns	6712	7797	8108	7369	22175	27838
Rate or return	2.21	1.80	1.51	1.52	2.26	1.53

Sources: Islam *et al.* 2000; Islam and Ali, 2004; Miah *et al.* 2005a; Alam *et al.* (2005b); Islam *et al.* 2010; Rahman *et al.* 2012

Table 11. Financial profitability of mungbean production in Bangladesh

Items	Cultivation year			
	2005a	2005b	2008a	2011a
Grain yield (kg/ha)	1018	1229	928	946
Price (Tk/kg)	23.00	23.93	43.16	48.39
Total Returns	23983	29848	40552	46423
Grain	23414	29404	40052	45773
Stover	569	444	500	650
Total costs	17264	17005	16003	20919
Net returns	6719	12843	24549*	25504*
Rate or return	1.39	1.76	2.53	2.22

Sources: Miah *et al.* 2005a; Alam *et al.* 2005b; Islam *et al.* (2008a); Islam *et al.* (2011a)

* Land use cost was not considered in calculating net return.

Table 12. Financial profitability of blackgram production in Bangladesh

Items	Cultivation year		
	2004	2005a	2007
Grain yield (kg/ha)	1088	1004	989
Price (Tk/kg)	18.03	17.66	30.10
Total Returns	20642	18866	31198
Grain	19617	17730	29773
Stover	1025	1136	1425
Total costs	5327	10421	8087
Net returns	15315*	8445	23111*
Rate or return	2.88	1.81	3.86

Source: Islam *et al.* 2004; Miah *et al.* 2005a; Islam and Matin, 2007

* Land use cost was not included in calculating net return.

Table 13. Financial profitability of chickpea production in Bangladesh

Items	Cultivation year		
	2000	2002	2008
Grain yield (kg/ha)	788	1131	488
Price (Tk./kg)	18.35	18.37	24.91
Total Returns	14460	20771	12154
Total costs	5153	6645	7758
Net returns	9307	14126	4396
Rate or return	2.81	3.13	1.57

Sources: Islam et al. 2000; Islam et al. 2002; Islam, 2008

Table 14. Financial profitability of onion production in Bangladesh

Particular	Cultivation year			
	2011	2011	2010	1997
Bulb yield (kg/ha)	11579	9869	13333	5910
Average bulb price (Tk/kg)	25.0	17.53	15.25	6.00
Flower stalk (kg/ha)	--	--	367	--
Price of stalk (Tk/kg)	--	--	6.28	--
Gross returns (Tk/ha)	293566	173004	205896	35476
Total cost of production (Tk/ha)	198306	93517	118495	26963
Net return (Tk/ha)	95260	79487	87401	8512
Input-output ratio or BCR	1.48	1.85	1.74	1.32

Source: Haque et al. (2011); Hasan (2010); Islam and Rahman (2011); EPC (1997)

Table 15. Financial profitability of garlic production in Bangladesh

Particular	Cultivation year			
	2011	2010	2009	2006
Garlic yield (kg/ha)	4392	7750	6157	5385
Average price (Tk/kg)	105	65.733	19.88	27.39
Gross returns (Tk/ha)	461152	509433	122407	147495
Total cost of production (Tk/ha)	218150	207345	65416	72043
Net return (Tk/ha)	243002	302088	56991	75452
Benefit Cost Ratio	2.11	2.45	1.87	2.05

Source: Islam and Rahman (2011); Islam (2010); Haque et al. (2009); Baree et al. (2006)

Table 16. Financial profitability of turmeric (dry) production in Bangladesh

Particular	Cultivation year		
	2011	2011 ^a	1997
Turmeric yield (kg/ha)	3250	6000	2440
Average price (Tk/kg)	72.00	88.56	26.03
Gross returns (Tk/ha)	233594	531367	63513
Total cost of production (Tk/ha)	129977	23408	20078
Net return (Tk/ha)	103617	435017	43435
Benefit Cost Ratio	1.79	2.27	2.16

Source: Islam and Rahman (2011); Karim (2011^a); EPC (1997)

Table 17. Financial profitability of ginger production in Bangladesh

Particular/Crops	Cultivation year		
	2011	2010	1997
Yield (kg/ha)	9170	5904	4600
Average price (Tk/kg)	80	90	16.70
Gross returns (Tk/ha)	733667	531367	76820
Total cost of production (Tk/ha)	244556	202855	32557
Net return (Tk/ha)	489111	328512	44263
Input-output ratio or BCR	2.99	2.62	2.36

Sources: Islam and Rahman (2011); Nahar (2010); EPC, 1997

Table 18. Financial profitability of chili production in Bangladesh

Particular	Cultivation year		
	1984 (Green)	2010 (Green)	2011 (Dry)
Yield (kg/ha)	3780	7052	1800
Average price (Tk/kg)	7.99	21.57	180
Gross returns (Tk/ha)	30187	152114	324869
Total cost of production (Tk/ha)	11031	78950	155009
Net return (Tk/ha)	19156	73164	169860
Input-output ratio or BCR	2.74	1.93	2.09

Sources: Islam and Rahman (2011); Huq and Arshad (2010); Elias and Hossain (1984)

Table 19. Financial profitability of potato production in Bangladesh

Cultivation year	Yield (kg/ha)	Sale price (Tk/kg)	Gross return (Tk/ha)	Total cost (Tk/ha)	Net return (Tk/ha)	BCR
2010	14200	15.00	213000	129855	83145	1.64
2009a	13775	15.00	206623	129327	77296	1.60
2009b	22251	10.95	243638	154662	88976	1.58
2009c	23120	15.00	346800	192315	154485	1.80
2008	24900	12.00	298800	124481	174319	2.40

Sources: Sarker et al. 2009a; Azimuddin et al. 2009b; Hossain and Miah, 2009c; Parvin, 2010; Hossain et al. 2008

Table 20. Financial profitability of different vegetables production in Bangladesh

Cultivation year	Yield (kg/ha)	Price (Tk/kg)	Gross return (Tk/ha)	Total cost (Tk/ha)	Net return (Tk/ha)	BCR	Sources
1. Brinjal							
1997	11730	6.00	70372	17343	53029	4.06	EPC, 1997
1998	24699	2.51	61994	31339	30655	1.98	Miah et al., 1998
2002	43899	7.09	310293	177457	132836	1.75	Rashid et al. 2002
2. Cabbage							
1998	48029	2.26	108546	61793	46753	1.76	Miah et al., 1998
1998	13750	5.08	69846	25337	18052	1.35	Mawla, 1998
2009	22000	10.00	220000	120522	99478	1.83	Akter, 2009
3. Cauliflower							
1998	40102	2.58	103462	57590	45872	1.80	Miah et al., 1998
1998	11260	6.09	68580	50875	17705	1.35	Mawla, 1998
2008	13680	9.85	134748	63415	72820	2.12	Islam et al., 2008
2009	21000 no.	10.00	210000	116977	93023	1.80	Akter, 2009
4. Tomato							
1998	12260	5.05	61870	45365	16505	1.36	Mowla, 1998
2000*	12250	23.37	286233	55538	230695	5.15	Hossain et al., 2000
2009	118000	12.00	217020	18085	99020	1.84	Akter, 2009
2010	198308	14.00	359926	25709	161618	1.81	Parvin, 2010
5. Bittergourd							
1996	4930	4.95	24418	34523	10105	1.41	Hakim, 1996
2010	32600	22.00	717200	306810	410390	2.34	Karim & Mostofa, 2010
6. Snakegourd							
1993	28520	4.00	114075	61153	52922	1.87	Anon, 1993
2010	27500	8.50	233750	120125	113625	1.95	Karim & Mostofa, 2010
7. Riddegourd							
2010	17800	9.50	169100	113344	55756	1.49	Karim & Mostofa, 2010
8. Bottlegourd							
1998	9560 no.	6.12	58480	43614	14866	1.34	Mawla, 1998
2009	10000 no.	20.00	200000	105344	94656	1.90	Khayer, 2009
9. Whitegourd							
1993	35685 no.	5.00	178430	67963	110467	2.63	Anon, 1993
1999	19763 no.	3.40	67249	26058	41191	2.58	Islam et al., 1999
10. Okra							
1997	6360	6.60	41976	14949	27027	2.81	EPC, 1997
2000	11417	5.52	63047	23487	39560	2.68	Hossain et al., 2000
2008	15630	9.76	152597	57775	94822	2.64	Islam et al., 2008
12. Bean							
1998	8370	5.68	47513	38772	8741	1.23	Mawla, 1998
2009	8650	20.00	174500	104840	69660	1.66	Khayer, 2009
13. Cucumber							
1997	--	--	75848	43767	32080	1.73	Hussain, 1997
14. Pointed gourd							
1996	5840	8.00	46718	31851	14867	1.47	Hakim, 1996
15. Radish							
1998	11.30		46200	33700	12500	1.37	Mawla, 1998
16. Aroids							
1996	11870	5.55	65906	35389	30517	1.86	Haque and Haque, 1996

* Profitability of summer tomato cultivation

Table 21. Profitability of mango production in selected areas of Bangladesh

Production Year	Yield (t/ha)	Price (Tk/ton)	Gross return (Tk/ha)	Total cost (Tk/ha)	Net return (Tk/ha)	BCR (undiscounted)
1 st year	--	--	--	63944	-63944	--
2 nd year	--	--	--	53183	-53183	--
3 rd year	--	--	--	49320	-49320	--
5 th year	120	1308.6	157036	93833	63203	1.67
10 th year	242	1304.8	315759	80375	235384	3.93
15 th year	284	1403.9	398720	95318	303402	4.18
20 th year	324	1308.4	423932	82529	341403	5.14
25 th year	284	1305.3	370702	87650	283052	4.23

Results: BCR (discounted at 10%) = 2.25, Net present value = Tk.1086842, and IRR = 19.5%

Source: Matin et al. (2009)

Table 22. Profitability of orange production in the hill areas of Bangladesh

Production Year	Yield (No./ha)	Price (Tk/unit)	Gross return (Tk/ha)	Total cost (Tk/ha)	Net return (Tk/ha)	BCR (undiscounted)
1 st year	--	--	--	65330	-65330	--
2 nd year	--	--	--	52930	-52930	--
3 rd year	--	--	--	53180	-53180	--
4 th year	46930	6.50	305045	53620	251425	5.69
5 th year	54340	6.50	353210	57850	295360	6.11
6 th year	61750	6.50	401375	58192	343183	6.90
7-15 th year	74100	6.50	481650	60760	420890	7.93
16-20 th year	49400	6.50	321100	61897	259203	5.19

Results: BCR (discounted at 12%) = 3.0, Net present value = Tk.522782, and IRR = 73.0%

Source: Hossain et al. 2011

Table 23. Profitability of guava production in Bangladesh in 2003

Production Year	Yield (kg/ha)	Price (Tk/ton)	Gross return (Tk/ha)	Total cost (Tk/ha)	Net return (Tk/ha)	BCR (undiscounted)
1 st year	--	--	--	37455	-37455	0
2 nd year	6232	4.00	24927	27944	-3017	0.89
3 rd year	19205	4.00	76820	32719	44101	2.35
4 th year	31987	4.00	127949	31739	96210	4.03
5 th year	35230	4.00	140920	29928	110992	4.71
6 th year	22482	4.00	89926	26630	63296	3.38
Average	19189	4.00	76757	31069	45688	2.47

Source: Rahman et al. 2003.

Table 24. Profitability of pineapple production in hill areas of Bangladesh

Production Year	Yield (No./ha)	Price (Tk/unit)	Gross return (Tk/ha)	Total cost (Tk/ha)	Net return (Tk/ha)	BCR (undiscounted)
1 st year	--	--	--	73051	-73051	--
2 nd year	--	--	--	34397	-34397	--
3 rd year	14820	9.50	140790	48917	91873	2.88
4 th year	16055	9.50	152522	49665	102857	3.07
5 th year	17290	9.50	164255	50395	113860	3.26
6 th year	16796	9.50	159562	48845	110717	3.27
7 th year	15808	9.50	150176	43937	106239	3.42

Results: BCR (discounted at 12%) = 1.82, Net present value = Tk.198104, and IRR = 56.77%

Source: Hossain et al., 2011

Table 25. Comparative profitability of pineapple production under traditional and contour method

Particular	Traditional method (Tk./acre)	Contour method (Tk./acre)	Difference (Tk./acre)
Land preparation	8,100	8,100	0
Fertilizing	21,880	9,950	(-) 1,930
Sucker planting	19,700	26,140	(+) 6,440
Weeding and clearing	16,650	12,510	(-) 4,140
Total costs	66,330	66,700	(+) 370
Total income	119,960	195,320	(+) 75,360
Net income	53,630	128,620	(+) 74,990
BCR	1.81	2.93	

Source: Bhuiyan, 2006

Table 26. Profitability of jackfruit production with pineapple intercropping for 25 years

Age of orchard (year)	Gross cost (Taka)	Gross return (Taka)	Cash flow (CF) (Taka)	Discounted CF at 30% DR (Taka)	Discounted CF at 40% DR (Taka)	Discounted gross cost at 12% DR (Taka)	Discounted gross return at 12% DR (Taka)	Net Present Value of Tk. at 12% DR (Taka)
1 st year	40158	0	-40158	-40158	-40158	40158	0	-40158
2 nd year	22800	35000	12200	9382	8711	20360	31255	10895
3 rd year	22800	35000	12200	7222	6222	18172	27895	9723
4 th year	23998	35700	11702	5324	4260	17087	25418	8332
5 th year	24148	36000	11852	415	3082	15358	22896	7538
6-10 th year	154176	235000	80824	13117	8050	69357	105617	36260
11-15 th year	216048	335000	118952	5286	2278	55462	85932	30470
16-20 th year	279616	435000	155384	1879	542	40872	63538	22666
21-25 th year	321400	1303000	981600	2175	108	26902	94898	67996
Total				4641	-6906	303729	457449	153720

Result: BCR at 12% = 1.51, NPV at 12% = Tk. 1,53,720 per ha, and IRR = 51%

Source: Hasan et al. 2008

Table 27. Financial profitability of dairy cow rearing in Bangladesh, 2002-2009

Particulars	Year: 2009		2005	2005	2002	
	Local breed	Cross-breed	Cross-breed	Cross-breed	Local breed	Cross-breed
1. Dairy cows per farm (No.)	4.46	4.84	11.53	7.5	1.57	12.62
2. Total cost (Tk/farm/year)	70972	160704	269265	208642	15976	529608
3. Milk production (litre/farm/year)	1953.5	6664.7	19768	13252	936.6	29217
4. Price of milk (Tk/litre)	35.33	35.32	18.90	16.5	19.40	20.81
5. Gross returns (Tk/farm/year)	98000	305586	426835	306478	22390	725479
Income from milk	69007	235364	373615	218664	18170	618090
Other incomes	28993	70222	53220	87815	4220	107389
6. Net return (Tk/farm/year)	27028	144882	157570	97837	6414	195871
7. Net return (Tk/cow/year)	6060	29934	13666	12867	4085	15521
8. Benefit cost ratio	1.38	1.90	1.59	1.45	1.40	1.37

Source: Miah, 2002; Jahan, 2005; Islam, 2005; Rahman, 2009; Choudhury, 2005

Table 28. Profitability of beef cattle fattening per cattle in the study areas

Particulars	Year: 2011a			Year: 2011b		
	Landless farmer	Small farmers	Average	Small farm (5 Cattle)	Medium farm (10 Cattle)	Average
Purchase price (Tk)	4740	4782	4761	9162	8962	9062
Total cost (Tk)	10598	10015	10307	16649	16149	16399
Gross returns (Tk)	12653	13027	12840	21967	21830	21899
Net return (Tk)	2055	3012	2533	5318	5681	5500
Benefit cost ratio	1.19	1.30	1.25	1.32	1.35	1.34

Source: Hasan et al. 2011a, Sarma and Ahmed, 2011b

Table 29. Profitability of goat farming in Bangladesh, 2005-2008

Particulars	Year: 2008		Year: 2006			Year: 2005		
	3.4	4.6	2	5	10	3	5	7
No. of goat per farm	3.4	4.6	2	5	10	3	5	7
Purchase price (Tk/farm)	--	--	1705	2650	5580	3300	5600	7800
Total cost (Tk/farm/year)	6722	11275	6447	11160	22474	16696	27423	31241
Variable cost	4633	7905	2367	4230	8542	12328	20223	21397
Fixed cost	2089	3370	4080	6931	13933	4368	7200	9844
Gross returns (Tk/farm/year)	9195	17010	9185	17077	36461	22764	27242	46019
Net profit (Tk/farm/year)	2473	5735	2738	5917	13987	6068	-181	14778
Net profit (Tk/goat/year)	727	1247	1369	1183	1399	2023	-36	2111
Benefit cost ratio	1.37	1.51	1.42	1.53	1.62	1.36	0.99	1.47

Sources: Khan, 2005; Alam, 2006; Akteruzzaman et al. 2008

Table 30. Financial profitability of broiler farming in Bangladesh, 2002-2009

Particular	Farming year			
	2009	2007	2006	2002
Bird per batch or farm (No.)	500	19211	8018	100
Total cost (Tk/batch)	63367	2090542	464991	8541
Average price (Tk/bird)	140.30	109.20	73.51	111.73
Gross returns (Tk/batch)	70150	2155347	590491	11268
Net return (Tk/batch)	6783	64805	122500	2727
Net return (Tk/bird)	13.57	3.37	15.28	27.27
Benefit cost ratio	1.12	1.03	1.27	1.32

Source: Sultana, 2009; Rahman, 2007; Hossain, 2006; Miah, 2002

Table 31. Financial profitability of commercial layer farming

Particular	Farming year			
	2009	2002	1995	1995
Bird per batch or farm (No.)	1000	100	6704	209
Total cost (Tk/batch)	1263032	66701	715165	10733
Average price of culls (Tk/bird)	165	133	48.22	28.92
Gross returns (Tk/batch)	1439816	118889	874847	14072
Net return (Tk/batch)	176784	52188	159682	3339
Net return (Tk/bird)	177	522	23.82	15.98
Benefit cost ratio	1.14	1.78	1.22	1.31

Source: Miah, 2002; Nahar et al. 2009; Alam et al. 1995

Table 32. Profitability of fish farming in Bangladesh during 2006-2011

Particulars	2011	2009			2007	2006	
	Koi fish	Rice-fish	Pond fish	Shrimp	Carp fish	Carp fish	Pangas
Total cost (Tk/ha)	2135624	61173	212683	106791	114649	88821	637113
Yield (kg/ha)	22179	4860	4505.16	433.84	4381	3656.2	--
Price (Tk/kg)	123.40	24.13	70.00	364.0	45.90	46.99	--
Gross return (Tk/ha)	2736869	117280	315361	190815*	201090	171794	837011
Net return (Tk/ha)	601245	56107	102678	84024	86441	82973	199898
BCR	1.28	1.92	1.48	1.79	1.75	1.93	1.31

Sources: Sarker, 2011; Yesmin, 2009; Akhter, 2009; Feroz, 2009; Haque, 2007; Nurunnahar et al., 2006; Mian et al., 2006 *Note: Income from shrimp was Tk.1,57,978 and from other fish species was Tk.32,837

Table 33. Growth rates of area, production and yield of *Aus* rice by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	-6.6**	-9.6***	-6.9***	-7.2**	-9.4**	-9.2 ^{ns}	-12.0**	-8.2***
1995-1999	2.2 ^{ns}	0.8 ^{ns}	-5.6***	-1.0 ^{ns}	-0.6 ^{ns}	-5.5*	-9.8***	-2.8*
2000-2004	2.2***	0.6 ^{ns}	-5.3***	-9.7***	2.7 ^{ns}	-5.2 ^{ns}	-20.4*	-2.9***
2005-2009	-1.5 ^{ns}	-3.2 ^{ns}	-14.6*	7.4 ^{ns}	17.6***	-1.8 ^{ns}	-6.3 ^{ns}	-0.4 ^{ns}
1990-2009	0.4 ^{ns}	-1.9***	-8.3***	-5.3***	-1.7*	-3.8***	-19.5***	-4.3***
Prod (mt)								
1990-1994	-8.6**	-8.7**	-6.0*	-3.7 ^{ns}	-6.0**	-8.3 ^{ns}	-10.8**	-7.0***
1995-1999	4.2*	3.3 ^{ns}	-5.2 ^{ns}	1.2 ^{ns}	3.8 ^{ns}	-6.4 ^{ns}	-3.2*	-0.8 ^{ns}
2000-2004	5.2*	4.1 ^{ns}	-0.2 ^{ns}	-7.3**	3.6 ^{ns}	-1.0 ^{ns}	-8.7 ^{ns}	0.7 ^{ns}
2005-2009	0.5 ^{ns}	-2.4 ^{ns}	-6.8 ^{ns}	7.5 ^{ns}	20.6***	4.2 ^{ns}	-1.3 ^{ns}	3.1 ^{ns}
1990-2009	3.2***	0.2 ^{ns}	-6.1***	-2.8***	1.4 ^{ns}	-1.8**	-15.2***	-1.7***
Yield (t/ac)								
1990-1994	-2.0 ^{ns}	0.9 ^{ns}	0.9 ^{ns}	3.5 ^{ns}	3.3 ^{ns}	0.9 ^{ns}	1.8**	1.2 ^{ns}
1995-1999	2.0 ^{ns}	2.4 ^{ns}	0.4 ^{ns}	2.2**	4.5 ^{ns}	-0.8 ^{ns}	7.4*	2.0 ^{ns}
2000-2004	3.0*	3.5 ^{ns}	5.1 ^{ns}	2.3 ^{ns}	0.9 ^{ns}	4.1*	11.4 ^{ns}	3.7*
2005-2009	2.1 ^{ns}	0.8 ^{ns}	7.7**	0.04 ^{ns}	3.0 ^{ns}	6.1 ^{ns}	4.3 ^{ns}	3.6 ^{ns}
1990-2009	2.7***	2.1***	2.1***	2.5***	3.2***	1.9***	3.6***	2.6***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 34. Growth rates of area, production and yield of Aman rice by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	-0.1 ^{ns}	-0.01 ^{ns}	1.3 ^{ns}	0.4 ^{ns}	0.07 ^{ns}	0.6 ^{ns}	-0.4 ^{ns}	0.2 ^{ns}
1995-1999	-0.7 ^{ns}	-3.8 ^{ns}	-4.4 ^{ns}	-1.8 ^{ns}	0.5 ^{ns}	0.5 ^{ns}	3.8 ^{ns}	-1.0 ^{ns}
2000-2004	0.1 ^{ns}	-0.3 ^{ns}	0.9 ^{ns}	-0.3 ^{ns}	0.1 ^{ns}	-1.0 ^{ns}	-1.1 ^{ns}	-0.1 ^{ns}
2005-2009	0.7 ^{ns}	2.2 ^{ns}	-0.2 ^{ns}	3.5 ^{**}	1.0 ^{ns}	0.7 ^{ns}	0.0 ^{ns}	1.0 ^{ns}
1990-2009	-0.1 ^{ns}	-1.1 ^{***}	-0.4 ^{ns}	-0.5 ^{***}	-0.1 ^{ns}	-0.7 ^{**}	-0.3 ^{ns}	-0.5 ^{***}
Prod (mt)								
1990-1994	-0.3 ^{ns}	0.6 ^{ns}	2.3 [*]	1.2 ^{ns}	1.6 ^{ns}	1.9 ^{ns}	-0.1 ^{ns}	1.0 ^{ns}
1995-1999	-2.4 ^{ns}	-6.3 ^{**}	-6.9 ^{ns}	-0.3 ^{ns}	2.4 ^{ns}	1.6 ^{ns}	-1.3 ^{ns}	-2.2 ^{ns}
2000-2004	0.6 ^{ns}	3.2 ^{ns}	3.4 ^{ns}	2.6 ^{ns}	1.5 ^{ns}	2.9 [*]	0.3 ^{ns}	2.1 ^{ns}
2005-2009	-0.3 ^{ns}	3.1 ^{ns}	1.1 ^{ns}	3.2 [*]	3.6 ^{**}	3.3 ^{ns}	4.3 [*]	2.8 ^{ns}
1990-2009	1.0 ^{ns}	0.2 ^{ns}	1.7 ^{***}	1.2 ^{***}	1.4 ^{***}	1.4 ^{***}	0.6 ^{ns}	1.1 ^{***}
Yield (t/ac)								
1990-1994	-0.2 ^{ns}	0.6 ^{ns}	1.0 ^{ns}	0.8 ^{ns}	1.5 ^{ns}	1.3 ^{ns}	0.2 ^{ns}	0.7 ^{ns}
1995-1999	-1.7 ^{ns}	-2.5 ^{ns}	-2.5 ^{ns}	1.5 ^{ns}	1.9 ^{ns}	1.0 ^{ns}	-5.6 ^{ns}	-1.2 ^{ns}
2000-2004	0.4 ^{ns}	3.5 ^{ns}	2.5 ^{ns}	2.9 ^{ns}	1.3 ^{ns}	3.9 ^{***}	1.6 ^{ns}	2.2 ^{ns}
2005-2009	-1.1 ^{ns}	0.8 ^{ns}	1.4 ^{ns}	-0.2 ^{ns}	2.5 ^{ns}	2.6 ^{ns}	4.6 ^{**}	1.7 ^{ns}
1990-2009	1.1 [*]	1.4 ^{***}	2.1 ^{***}	1.8 ^{***}	1.5 ^{***}	2.2 ^{***}	1.0 ^{***}	1.5 ^{***}

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 35. Growth rates of area, production and yield of Boro rice by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	-7.8 [*]	0.2 ^{ns}	5.7 ^{ns}	2.7 ^{ns}	0.9 [*]	1.3 ^{ns}	4.3 ^{**}	0.7 ^{ns}
1995-1999	13.1 ^{**}	3.3 [*]	5.2 ^{**}	6.7 ^{***}	6.1 [*]	2.7 ^{ns}	9.3 [*]	6.1 [*]
2000-2004	3.8 ^{**}	2.6 ^{**}	0.3 ^{ns}	2.6 ^{ns}	4.0 ^{***}	-0.1 ^{ns}	1.1 ^{ns}	1.8 ^{***}
2005-2009	13.7 ^{***}	1.6 ^{ns}	4.8 ^{***}	5.7 ^{***}	1.6 [*]	3.5 [*]	6.3 ^{***}	4.2 ^{***}
1990-2009	5.1 ^{***}	1.5 ^{***}	3.3 ^{***}	6.7 ^{***}	4.1 ^{***}	1.6 ^{***}	6.4 ^{***}	3.6 ^{***}
Prod (mt)								
1990-1994	-6.8 [*]	-0.3 ^{ns}	1.0 [*]	2.6 ^{ns}	4.0 ^{**}	5.8 ^{ns}	6.3 ^{**}	2.2 [*]
1995-1999	20.1 ^{***}	8 ^{**}	10 ^{***}	16.8 ^{***}	9.2 ^{**}	6.9 ^{***}	12.4 ^{**}	10.8 ^{***}
2000-2004	2.4 ^{ns}	3.3 ^{***}	2.5 ^{**}	4.2 ^{ns}	5.5 ^{***}	1.7 ^{ns}	2.1 ^{ns}	3.3 ^{**}
2005-2009	17 ^{***}	4.6 ^{ns}	7.0 ^{**}	7.2 ^{***}	6.3 ^{**}	6.5 ^{ns}	11.1 ^{***}	7.4 ^{***}
1990-2009	7.3 ^{***}	3.6 ^{***}	5.3 ^{***}	8.8 ^{***}	6.3 ^{***}	5.2 ^{***}	8.5 ^{***}	6.0 ^{***}
Yield (t/ac)								
1990-1994	0.9 ^{ns}	-0.5 ^{ns}	-4.7 ^{ns}	-0.1 ^{ns}	3.1 ^{**}	4.5 ^{ns}	2.2 ^{***}	1.5 ^{**}
1995-1999	6.9 ^{***}	4.7 ^{**}	5.8 ^{***}	10.0 [*]	3.1 ^{***}	4.2 ^{**}	3 ^{***}	4.7 ^{***}
2000-2004	-1.4 ^{ns}	0.7 ^{***}	2.2 ^{**}	1.6 ^{**}	1.5 ^{***}	1.8 ^{ns}	1.2 ^{ns}	1.5 ^{**}
2005-2009	3.2 [*]	3.0 ^{ns}	2.3 ^{ns}	1.5 ^{ns}	4.7 ^{**}	3.0 ^{ns}	4.8 ^{**}	3.2 ^{**}
1990-2009	2.3 ^{***}	2.2 ^{***}	2.0 ^{***}	2.1 ^{***}	2.1 ^{***}	3.7 ^{***}	2.0 ^{***}	2.4 ^{***}

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 36. Growth rates of area, production and yield of wheat by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	-6.1 ^{ns}	-8.6 ^{ns}	0.5 ^{ns}	1.1 ^{ns}	5.2***	1.2 ^{ns}	2.3 ^{ns}	1.4 ^{ns}
1995-1999	13.8*	7.0***	8.2***	3.8*	6.6***	-31*	12.0***	7.8***
2000-2004	-26***	-6.8 ^{ns}	-9.7***	-6.6***	-3.9**	12.8 ^{ns}	-4.2***	-6.1***
2005-2009	-0.6 ^{ns}	-20.9***	-4.8 ^{ns}	-4.4 ^{ns}	-8.8*	-24.0*	-12.9***	-9.1**
1990-2009	-2.2 ^{ns}	-5.4***	-2.8***	-3.0***	-0.7 ^{ns}	-1.9***	-0.6 ^{ns}	-1.9**
Prod (mt)								
1990-1994	6.3 ^{ns}	1.9 ^{ns}	6.6***	10.8**	10.6*	6.8 ^{ns}	1.0 ^{ns}	6.4**
1995-1999	11.2*	5.1**	11.5***	5.5**	11.1***	-30.0	17.8***	11.3***
2000-2004	-24.0**	-8.3**	-10.9***	-8.6***	-5.2***	13.3 ^{ns}	-10.6**	-8.7***
2005-2009	12.3 ^{ns}	-19.7***	3.4 ^{ns}	7.0**	-2.7 ^{ns}	-19.5 ^{ns}	-5.1 ^{ns}	-1.4 ^{ns}
1990-2009	-0.7 ^{ns}	-6.5***	-2.5*	-2.3*	0.5 ^{ns}	-9.5***	-0.2 ^{ns}	-1.2 ^{ns}
Yield (t/ac)								
1990-1994	12.4***	10.5***	6.1**	9.2**	5.4 ^{ns}	5.6 ^{ns}	-1.4 ^{ns}	5.0**
1995-1999	-2.6 ^{ns}	-1.9*	3.3**	1.6*	4.5**	1.2 ^{ns}	5.5**	3.5**
2000-2004	1.4 ^{ns}	-1.5 ^{ns}	-1.2**	-2.0**	-1.3*	0.5 ^{ns}	-5.9 ^{ns}	-2.6*
2005-2009	12.9***	1.2 ^{ns}	8.2*	11.3***	6.1 ^{ns}	4.5 ^{ns}	6.6 ^{ns}	7.6*
1990-2009	1.4**	-1.1 ^{ns}	0.3 ^{ns}	0.7 ^{ns}	1.3***	1.4**	0.3 ^{ns}	0.7 ^{ns}

Note: '***' '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 37. Growth rates of area, production and yield of maize by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	--	-1.1 ^{ns}	-33.0***	-18.4 ^{ns}	-22.0***	--	17.4***	-4.8***
1995-1999	--	-3.8 ^{ns}	11.6 ^{ns}	8.6 ^{ns}	1.2 ^{ns}	--	21.9***	0.3 ^{ns}
2000-2004	39.7*	14.3***	68.3***	122.0**	101.0***	--	83.4***	69.5***
2005-2009	65.4**	7.7*	10.0 ^{ns}	5.2 ^{ns}	15.2 ^{ns}	--	35**	21.2 ^{ns}
1990-2009	38.4***	6.4***	30.4***	44.0***	29.7***	--	40.6***	25.4***
Prod (mt)								
1990-1994	--	-1.4 ^{ns}	-28.4***	-21.3 ^{ns}	-23.7**	--	15.1***	-4.8*
1995-1999	--	-3.8 ^{ns}	12.8 ^{ns}	13.6 ^{ns}	8.3***	--	30.3***	2.0 ^{ns}
2000-2004	36.1*	21.0***	78.0***	152.0***	142.0***	--	105***	105.0***
2005-2009	78.2*	17.0**	7.8 ^{ns}	5.5 ^{ns}	15.5 ^{ns}	--	37.8*	23.8 ^{ns}
1990-2009	45.4***	13.8***	41.1***	52.4***	43.9***	--	55.1***	37.9***
Yield (t/ac)								
1990-1994	--	-0.3 ^{ns}	4.7*	-2.9*	-1.6 ^{ns}	--	-2.4 ^{ns}	0.0 ^{ns}
1995-1999	--	0.0 ^{ns}	1.2 ^{ns}	5.0*	7.1**	--	8.7**	1.6**
2000-2004	-3.6 ^{ns}	6.9*	10.4**	29.6***	40.3**	--	22 ^{ns}	36.4***
2005-2009	12.8 ^{ns}	9.4**	-2.3 ^{ns}	0.3 ^{ns}	0.3 ^{ns}	--	3.4 ^{ns}	2.6 ^{ns}
1990-2009	7.0**	7.5**	10.7***	8.4***	14.2***	--	14.5***	12.5***

Note: '***' '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 38. Growth rates of area, production and yield of sugarcane by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	-8.7**	-4.2**	2.9 ns	0.6 ns	-0.4 ns	2.3***	-2.8**	-0.9 ns
1995-1999	-10.6***	1.8**	-0.3 ns	0.4 ns	-1.6***	1.5 ns	-0.7 ns	-0.7 ns
2000-2004	-7.8 ns	-0.3 ns	-1.3 ns	-3.6*	1.0 ns	0.4 ns	-1.1***	-1.0 ns
2005-2009	-2.1 ns	-3.7 ns	-7.2***	-9.2***	-4.7 ns	-6.4***	-25.8 ns	-6.0**
1990-2009	-9.4***	0.1 ^{ns}	-1.7***	-2.5***	-0.4 ^{ns}	0.3 ^{ns}	-1.9***	-1.5***
Prod (mt)								
1990-1994	-5.5 ns	1.5 ns	-0.3 ns	0.5 ns	-2.0***	4.4***	-2.6 ns	-1.1 ns
1995-1999	-20.6***	-2.0 ns	-1.7 ns	13.1 ns	-3.2**	7.2*	1.1 ns	-1.1 ns
2000-2004	-10.9 ns	-3.5**	-1.1 ns	-5.5*	3.7*	0.7 ns	-3.9**	-1.1 ns
2005-2009	-32.4**	-9.7 ns	-9.1 ns	-12.6***	-1.3 ns	-27.8 ns	-1.0 ns	-5.1**
1990-2009	-14.3***	-2.3***	-2.5***	-2.8*	-0.2 ^{ns}	-4.8**	-3.1***	1.8***
Yield (t/ac)								
1990-1994	3.2 ns	5.8***	-3.2 ns	-0.1 ns	-1.7**	2.1**	0.5 ns	-0.1 ns
1995-1999	-10.0***	-3.8***	-1.4 ns	12.7 ns	-1.6 ns	5.7*	2.2 ns	-0.4 ns
2000-2004	-3.1**	-3.2**	0.2 ns	-1.9 ns	2.7***	0.3 ns	-3.6**	-0.2 ns
2005-2009	-30.3***	-6.0 ns	-1.9 ns	-3.4***	3.3 ns	-21.4 ns	36.7 ns	0.9 ns
1990-2009	-4.9***	-2.4***	-0.8**	-0.3 ^{ns}	0.2 ^{ns}	-5.1***	-1.1**	0.3***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 39. Growth rates of area, production and yield of potato by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	-6.4 ns	-0.8 ns	8.1***	5.4***	-0.2 ns	1.6 ns	2.3***	2.8**
1995-1999	35.8*	13.4 ns	6.5 ns	22.2*	11.0 ns	16.6 ns	17.3 ns	12.7 ns
2000-2004	-14.6***	0.1 ns	-0.1 ns	3.8*	8.2**	-0.4 ns	0.2 ns	2.0 ns
2005-2009	6.7 ns	4.3 ns	4.0 ns	4.0 ns	4.6***	-15.8*	12.8*	6.7*
1990-2009	10.1***	3.1***	3.7***	7.3***	9.0***	1.5 ^{ns}	10.8***	7.1***
Prod (mt)								
1990-1994	-2.9 ns	-2.0 ns	18.1***	10.8**	0.0 ns	0.3 ns	0.8 ns	7.1**
1995-1999	37.3*	17.1 ns	2.7**	26.3*	11.7 ns	16.6 ns	24.1 ns	13 ns
2000-2004	-12.6***	-0.6 ns	4.0*	5.6 ns	18.4**	1.6 ns	8.4 ns	6.2*
2005-2009	16.6 ns	5.8 ns	6.8 ns	-2.7 ns	2.4 ns	-9.9*	11.4 ns	6.3 ns
1990-2009	13.5***	4.4***	6.6***	10.1***	12.5***	2.5 ^{ns}	15.1***	9.5***
Yield (t/ac)								
1990-1994	3.6 ns	-1.2**	10.8**	5.4*	0.2 ns	-1.3 ns	-1.3 ns	4.3**
1995-1999	1.4 ns	3.7*	-3.8 ns	4.0*	0.7 ns	0.0 ns	7.1 ns	0.3 ns
2000-2004	2.0**	-0.8 ns	4.1*	1.8 ns	10.2**	2.0 ns	7.3 ns	4.2**
2005-2009	10.0**	1.5 ns	2.9 ns	-6.6*	-2.2 ns	5.9 ns	-0.8 ns	-0.4 ns
1990-2009	3.5***	1.3***	2.9***	2.8***	3.5***	1.0**	4.3***	2.4***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 40. Growth rates of area, production and yield of winter brinjal by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	2.6***	-1.6***	1.3**	3.7***	-2.5**	0.2 ns	1.2 ns	0.3*
1995-1999	14.9 ns	24.6 ns	20 ns	8.5*	8.1 ns	19.2 ns	19.8 ns	17.3 ns
2000-2004	2.4***	1.6***	-4.8*	-0.7 ns	-4.3***	-0.5 ns	-14.9 ns	-3.0**
2005-2009	21.9***	-19.3**	-0.3 ns	2.1 ns	0.5 ns	-19.7*	3.3***	-5.6*
1990-2009	4.4*	5.1***	4.6***	4.2***	0.3 ^{ns}	3.3**	3.4**	3.9***
Prod (mt)								
1990-1994	4.2***	-2.3**	0.4 ns	9.1***	-1.6 ns	-5.1***	-1.4 ns	0.5 ns
1995-1999	12.2 ns	23.3 ns	22.7 ns	5.2 ns	6.5 ns	21.1 ns	19.1 ns	16.5 ns
2000-2004	8.4***	1.3**	-6.2*	-2.4***	-3.5**	-5 ns	-15.6 ns	-3.5***
2005-2009	-18***	-20.7**	3.5 ns	7.2 ns	4.7**	-12.8 ns	11.5**	-1.6**
1990-2009	6.4***	4.0**	5.8***	4.6***	0.7 ^{ns}	1.3 ^{ns}	3.1*	4.1***
Yield (t/ac)								
1990-1994	1.7**	-0.7 ns	-0.9 ns	5.4**	0.9**	-5.3*	-2.8**	0.2 ns
1995-1999	-2.7 ns	-1.3 ns	2.6***	-3.3**	-1.6**	1.9 ns	-2.8***	-0.8**
2000-2004	5.9**	-0.3 ns	-1.4 ns	-1.7**	0.8 ns	-4.5 ns	1.6**	-0.5 ns
2005-2009	3.9 ns	-1.3 ns	3.7 ns	5.2 ns	4.2***	6.9 ns	8.0**	4.0 ns
1990-2009	2.0***	-1.0***	1.2***	0.4 ^{ns}	0.4**	-1.9***	-0.3 ^{ns}	0.2 ^{ns}

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 41. Growth rates of area, production and yield of cabbage by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	-0.9 ns	2.0**	3.6**	4.0**	-0.1 ns	-0.2 ns	1.3 ns	2.3**
1995-1999	4.9**	2.4**	2.1***	2.7***	3.0*	2.9***	3.7**	2.8***
2000-2004	3.3**	4.1**	4.2**	3.3*	6.2**	4.5 ns	1.1**	3.8**
2005-2009	10.8**	1.1 ns	4.7**	4.1*	2.7 ns	12.5**	7.1***	4.6**
1990-2009	3.5***	3.4***	4.0***	3.2***	3.2***	2.9***	3.3***	3.5***
Prod (mt)								
1990-1994	5.3***	2.8 ns	3.2**	4.5*	-0.4 ns	-1.6 ns	-0.7 ns	2.1**
1995-1999	7.2*	2.8**	4.1***	2.5 ns	2.2*	4.4**	-0.5 ns	2.6***
2000-2004	1.9 ns	4.8**	6.2**	5.2 ns	12.1*	3.3 ns	1.3***	5.5*
2005-2009	13.6*	2.2 ns	12.1**	4.0 ns	8.5**	12.6 ns	10.2**	8.1**
1990-2009	5.7***	3.5***	6.1***	4.3***	4.8***	4.1***	2.7***	4.5***
Yield (t/ac)								
1990-1994	6.2**	0.8 ns	-0.4 ns	0.5 ns	-0.3 ns	-1.4 ns	-1.9 ns	-0.1 ns
1995-1999	2.3 ns	0.4 ns	1.9**	-0.2 ns	-0.8 ns	1.6*	-4.0*	-0.2 ns
2000-2004	-1.4 ns	0.4*	2.0*	1.9 ns	5.8 ns	-1.2 ns	0.5**	1.7 ns
2005-2009	2.8 ns	1.1 ns	7.4**	-0.2 ns	5.8***	0.1 ns	3.4 ns	3.5*
1990-2009	2.2***	0.1 ^{ns}	2.1***	1.1**	1.5***	1.2**	-0.4 ^{ns}	1.0***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 42. Growth rates of area, production and yield of radish by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (ac)								
1990-1994	-0.1 ns	-0.7*	2.4***	0.5 ns	1.0 ns	-1.0 ns	-1.6**	0.4 ns
1995-1999	-1.7 ns	2.3**	2.0**	1.7**	-0.7 ns	-1.0 ns	2.1***	1.3*
2000-2004	0.4 ns	1.8**	1.1*	0.6 ns	2.5**	0.4 ns	1.1**	1.3***
2005-2009	-2.3 ns	-0.9 ns	3.0**	5.1 ns	2.2*	6.4*	6.6**	2.7*
1990-2009	-2.0**	-0.1 ^{ns}	1.7***	2.2***	0.1 ^{ns}	-0.5 ^{ns}	1.3***	1.5***
Prod (mt)								
1990-1994	2.8*	0.8 ns	0.9 ns	2.1*	2.7 ns	-0.9*	-0.7 ns	1.5*
1995-1999	-1.6 ns	4.5**	2.0**	2.1 ns	-1.1*	-2.9 ns	7.7 ns	2.2 ns
2000-2004	-0.3 ns	1.2 ns	-1.0ns	2.2 ns	3.2**	1.2 ns	1.1**	0.9 ns
2005-2009	-9.0 ns	-0.3 ns	7.4**	5.6 ns	5.2**	6.1 ns	7.8**	4.4**
1990-2009	-3.2***	-0.9 ^{ns}	1.8***	3.7***	0.1 ^{ns}	-0.9 ^{ns}	1.8***	1.9***
Yield (t/ac)								
1990-1994	2.9***	1.5 ns	-1.4 ns	1.7***	1.7*	0.1 ns	1.1 ns	1.1***
1995-1999	0.1 ns	2.1**	0.1 ns	0.4 ns	-0.4 ns	-1.9 ns	8 ns	0.9 ns
2000-2004	-0.7 ns	-0.5 ns	-2.1*	1.6 ns	0.7 ns	0.7 ns	-0.1 ns	-0.4 ns
2005-2009	-6.8 ns	0.5 ns	4.4*	0.4 ns	3.0***	-0.3 ns	-1.5 ns	1.7**
1990-2009	-1.2**	-0.8 ^{ns}	0.1 ^{ns}	1.5***	0.0 ^{ns}	-0.4 ^{ns}	0.6 ^{ns}	0.5***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 43. Growth rates of area, production and yield of okra by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangla desh
Area (acre)								
1990-1994	0.6 ns	5.5**	6.3**	7.0***	3.9**	-5.4 ns	-0.8 ns	4.2***
1995-1999	3.0**	5.9***	4.0**	2.4**	1.7***	1.6 ns	10.1***	4.5***
2000-2004	3.5**	6.4***	3.4***	5.5***	9.3***	3.4**	-0.3 ns	4.7***
2005-2009	5.2***	0.3 ns	11.0***	5.5***	9.3*	-22.7 ns	7.1 ns	6.8***
1990-2009	3.4***	4.6***	6.0***	5.5***	6.0***	0.9 ^{ns}	5.3***	5.3***
Prod (mt)								
1990-1994	1.3 ns	5.2**	11.4***	5.6**	4.5**	6.2 ns	-0.4 ns	5.9***
1995-1999	4.1*	4.9**	3.4*	2.3**	0.1 ns	2.4 ns	9.0***	3.7***
2000-2004	6.5***	8.4***	3.8***	6.3***	19.3***	-4.0 ns	3.6**	7.1***
2005-2009	1.1**	-1.4 ns	15.7*	13.0***	14.2**	0.4 ns	6.6 ns	9.7**
1990-2009	4.1***	4.6***	6.8***	8.4***	7.8***	1.7 ^{ns}	6.3***	6.6***
Yield (t/ac)								
1990-1994	0.7 ns	-0.3 ns	5.1***	-1.4 ns	0.6 ns	11.6*	0.1 ns	1.6**
1995-1999	1.0 ns	-1.0 ns	-0.6 ns	-0.1 ns	-1.6***	0.8 ns	-1.9 ns	-0.7 ns
2000-2004	3.0***	1.9*	0.4 ns	0.7*	10.0***	-7.4 ns	5.0***	2.4***
2005-2009	-4.1**	-1.7 ns	4.5 ns	7.5***	4.9**	23.1 ns	-0.4 ns	2.9 ns
1990-2009	0.7**	0.0 ^{ns}	0.9**	2.9***	1.8***	0.8 ^{ns}	1.0***	1.3***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 44. Growth rates of area, production and yield of bitter gourd by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	5.2**	3.1***	4.7***	3.5**	0.6 ns	-4.2*	-0.4 ns	2.5***
1995-1999	-1.5 ns	2.1**	0.5 ns	3.1***	-1.3*	0.5 ns	2.7***	1.2***
2000-2004	4.2*	5.7***	2.8*	4.2*	2.6 ns	2.2**	5.3*	4.0*
2005-2009	8.1**	1.0 ns	6.1**	-1.1 ns	8.1**	7.6***	8.1**	4.5***
1990-2009	2.7***	3.6***	3.1***	4.2***	2.0**	1.3***	1.8***	3.0***
Prod (mt)								
1990-1994	7.9**	3.5 ns	6.0**	7.2***	-0.8 ns	-7.4*	0.6 ns	3.6***
1995-1999	-3.6 ns	1.4*	-2.4*	-1.2 ns	-1.4 ns	-2.9 ns	3.0**	-0.4 ns
2000-2004	3.8**	6.7*	2.4 ns	5.5**	2.4 ns	1.7 ns	4.5*	4.4*
2005-2009	9.8***	-2.7 ns	13.0***	-3.9 ns	14.6***	15.7**	11.1***	5.8**
1990-2009	2.3***	4.0***	2.2***	6.4***	3.8***	0.3 ^{ns}	2.7***	3.6***
Yield (t/ac)								
1990-1994	2.7*	0.4 ns	1.3 ns	3.7**	-1.3**	-2.6 ns	0.9 ns	1.1**
1995-1999	-2.1 ns	-0.7**	-2.9*	-4.3**	-0.1 ns	-3.4***	0.0 ns	-1.5**
2000-2004	-0.3 ns	1.0 ns	-0.5 ns	1.2 ns	-0.2 ns	-0.5 ns	0.2 ns	0.3 ns
2005-2009	1.7 ns	-3.6 ns	6.9***	-2.8 ns	6.6**	8.1*	3.8**	1.3 ns
1990-2009	-0.4 ^{ns}	0.4**	-1.0*	2.2 ^{ns}	1.8 ^{ns}	-1.1 ^{ns}	1.1 ^{ns}	0.7***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 45. Growth rates of area, production and yield of pointed gourd by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	--	-7.1 ns	4.1***	4.2**	1.5*	--	-3.9***	1.2**
1995-1999	--	23.9 ns	13.5**	1.0 ns	18.5 ns	--	21.6*	15.0*
2000-2004	--	-23.2**	-2.9 ns	2.2 ns	-5.1***	--	0.9***	-1.7 ns
2005-2009	--	9.2*	5.6***	4.5***	8.4 ns	--	-4.6 ns	3.8***
1990-2009	--	-1.6 ^{ns}	4.7***	7.0***	4.7***	--	5.4***	5.7***
Prod (mt)								
1990-1994	--	-11.2 ns	7.8***	5.7***	1.7 ns	--	-2.4 ns	2.3**
1995-1999	--	16.6 ns	12.7***	2.7 ns	17.7 ns	--	21.7*	15.1*
2000-2004	--	-23.1***	-2.8 ns	3.9 ns	-0.7 ns	--	1.4**	0.3 ns
2005-2009	--	10.0**	7.8*	3.7*	10.3 ns	--	-0.2 ns	5.0***
1990-2009	--	-4.3**	5.0***	10.6***	5.8***	--	6.2***	7.6***
Yield (t/ac)								
1990-1994	--	-4.1 ns	3.8***	1.5 ns	0.2 ns	--	0.8 ns	1.1**
1995-1999	--	-7.3*	-0.9 ns	1.7 ns	-0.8**	--	-1.7**	0.1 ns
2000-2004	--	0.1 ns	0.1 ns	1.6 ns	4.3**	--	1.8 ns	2.1 ns
2005-2009	--	0.8 ns	2.3 ns	-0.8 ns	1.9 ns	--	3.8*	1.2 ns
1990-2009	--	-2.7***	0.3*	3.6***	1.1***	--	0.7***	1.9***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 46. Growth rates of area, production and yield of banana by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	-2.3**	0.1 ns	1.3***	1.1 ns	1.3 ns	-0.8*	-0.6**	-0.1 ns
1995-1999	0.0 ns	-0.7 ns	0.1 ns	1.7**	0.0 ns	-3.0 ns	0.0 ns	0.6 ns
2000-2004	1.5**	1.7 ns	6.7**	12.1**	5.6**	-8.5**	2 ns	4.5***
2005-2009	-4.5 ns	3.8 ns	-2.8*	3.3 ns	-7.3 ns	1.5 ns	3.4 ns	-0.6 ns
1990-2009	-1.1***	-0.2 ^{ns}	5.5***	5.5***	1.9***	-4.6***	0.9***	2.2***
Prod (mt)								
1990-1994	-2.6*	-1.1 ns	0.5**	2.6 ns	3.8**	-0.4 ns	-0.3 ns	0.0 ns
1995-1999	-0.9**	-7.2 ns	-0.7 ns	0.9 ns	6.8 ns	-5.2*	0.1 ns	-2.4 ns
2000-2004	-2.0 ns	-0.5 ns	5.3**	22.5***	4.8**	-13.0**	2.3 ns	4.9***
2005-2009	-21.9**	-5.7 ns	-3.0 ns	3.7 ns	-1.4 ns	-30.9*	15.6***	-26.1 ns
1990-2009	-4.4***	-3.6***	6.0***	8.9***	3.4***	-9.4***	2.5***	-1.0 ^{ns}
Yield (t/ac)								
1990-1994	-0.2 ns	-1.2 ns	-0.8 ns	1.5 ns	2.4***	0.4 ns	0.3 ns	0.1 ns
1995-1999	-0.9 ns	-6.5 ns	-0.8*	-0.8 ns	6.8 ns	-2.2**	0.0 ns	-3.0**
2000-2004	-3.5 ns	-2.2***	-1.4**	10.4**	-0.8**	-4.6**	0.3 ns	0.4 ns
2005-2009	-17.5**	-9.5 ns	-0.2 ns	0.4 ns	5.9 ns	-32.5**	11.3***	-25.5 ns
1990-2009	-3.3***	-3.4***	0.5*	3.4***	1.5***	-4.9***	1.8***	-3.3 ^{ns}

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 47. Growth rates of area, production and yield of pineapple by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (ac)								
1990-1994	2.6***	0.3 ns	1.3**	5.4 ns	-8.6 ns	0.5 ns	-7.0**	0.5*
1995-1999	-4.3**	-0.3 ns	0.9**	0.9 ns	-7.3*	-0.3 ns	2.8*	0.0 ns
2000-2004	2.0 ns	3.5 ns	10.0 ns	-8.7**	-9.4**	-6.3 ns	-3.7*	3.6 ns
2005-2009	-8.5***	-6.5 ns	2.7***	-9.2**	-2.9*	-34.1**	-2.9 ns	-3.9***
1990-2009	-2.8***	-1.1***	5.5***	-3.4***	-4.2***	-4.3***	-1.8***	1.2***
Prod (mt)								
1990-1994	10.0**	2.3*	-4.7 ns	6.9 ns	-9.2 ns	-3.7*	-6.3 ns	-1.9 ns
1995-1999	-3.5 ns	-2.2 ns	-1.1**	1.9 ns	-8.7*	-0.3 ns	4.7***	-0.4*
2000-2004	-0.2 ns	7.3 ns	14.7 ns	3.8 ns	-7.1*	-2.5 ns	-2.2 ns	7.4 ns
2005-2009	-14.5***	-4.3 ns	4.7 ns	-15.7**	-0.6 ns	-50.3***	-3 ns	-2.4 ns
1990-2009	-3.8***	0.5 ^{ns}	7.1***	-0.1 ^{ns}	-2.7***	-7.8***	-0.1 ^{ns}	2.6***
Yield (t/ac)								
1990-1994	7.4 ns	2.0*	-6.0*	1.5 ns	-0.6 ns	-4.3*	0.8 ns	-2.4*
1995-1999	0.8 ns	-1.9 ns	-1.9**	1.0**	-1.4 ns	0.0 ns	2.6*	-0.4 ns
2000-2004	-2.2 ns	3.8 ns	4.2 ns	12.5*	2.3*	3.9*	0.8 ns	3.8*
2005-2009	-6.0**	1.7 ns	2.0 ns	-6.5 ns	2.3 ns	-16.2 ns	-0.5 ns	1.5 ns
1990-2009	-1.1**	1.6***	1.6**	3.3***	1.5***	-3.5***	1.7***	1.4***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 48. Growth rates of area, production and yield of mango by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	0.7***	0.8**	0.3*	0.3**	0.6 ns	8.3 ns	-0.4 ns	0.8 ns
1995-1999	0.3*	0.4***	0.5***	-0.5 ns	-0.6 ns	-0.1*	0.1 ns	0.0 ns
2000-2004	-0.1 ns	0.7*	0.7 ns	0.3***	0.1*	-0.1*	10.8 ns	1.5*
1990-2004	0.3***	0.7***	0.5***	0.3***	0.2 ns	1.6 ns	-0.6 ns	0.3**
Prod (mt)								
1990-1994	3.7***	-0.6 ns	-2.6 ns	1.4 ns	2.6**	8.6***	-3.7**	1.0*
1995-1999	-15.5 ns	0.0 ns	0.9*	-0.1 ns	-0.3 ns	-1.7**	0.0 ns	-0.8*
2000-2004	4.4*	12.2*	7.1**	4.8**	8.7*	3.4*	7.7*	7.7**
1990-2004	-0.4 ns	1.7**	1.3**	1.5***	2.1***	1.3***	0.7 ns	1.5***
Yield (t/ac)								
1990-1994	3.0**	-1.4*	-2.9 ns	1.2 ns	2.0*	0.3 ns	-3.3**	0.2 ns
1995-1999	-15.8 ns	-0.4*	0.4 ns	0.4 ns	0.3 ns	-1.6*	-0.1 ns	-0.7 ns
2000-2004	4.5*	11.0*	6.4**	4.6*	8.5*	3.5*	-14.8 ns	6.3 ns
1990-2004	-0.7 ns	1.0 ns	0.8*	1.2***	1.9***	-0.3 ns	1.8 ns	1.2**

Note: '***' '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 49. Growth rates of area, production and yield of jackfruit by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	1.2**	0.5 ns	1.1**	1.5***	1.2***	0.9***	0.3 ns	0.4**
1995-1999	0.9**	0.9*	1.6*	-0.5 ns	1.1*	-0.1 ns	0.2 ns	0.8*
2000-2004	1.3 ns	0.6*	0.8**	0.4**	1.9*	-0.1 ns	0.3***	1.4***
1990-2004	0.9***	0.7***	1.2***	0.6***	1.1***	0.1 ns	0.3***	0.7***
Prod (mt)								
1990-1994	0.6 ns	-0.8 ns	0.3 ns	0.8 ns	1.1**	-0.3 ns	0.9 ns	0.3 ns
1995-1999	2.6**	0.7 ns	2.0 ns	0.3*	0.9*	-0.3 ns	0.2 ns	0.9*
2000-2004	-1.6**	1.9 ns	2.4**	0.4*	1.5*	-0.2 ns	0.2**	1.3***
1990-2004	0.5*	0.7***	1.4***	0.1 ns	0.9***	-0.1 ns	0.3***	0.7***
Yield (t/ac)								
1990-1994	-0.6 ns	-1.3*	-0.8***	-0.7 ns	-0.1 ns	-1.2 ns	0.4 ns	-0.1 ns
1995-1999	1.7 ns	-0.2 ns	0.3 ns	0.7 ns	-0.1 ns	-0.2 ns	-0.1 ns	0.2 ns
2000-2004	-3.0**	1.3 ns	1.6 ns	0.0 ns	-0.4**	-0.1 ns	-0.1**	-0.1 ns
1990-2004	-0.4 ns	0.0 ns	0.2 ns	-0.5***	-0.2***	-0.2**	0.0 ns	0.0**

Note: '***' '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 50. Growth rates of area, production and yield of lentil by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	1.0***	-2.4**	-0.1 ns	0.4*	-2.1***	4.0**	-0.5**	-0.3*
1995-1999	-3.4**	-0.3 ns	0.0 ns	0.0 ns	-0.4**	-1.1 ns	0.4 ns	-0.2*
2000-2004	-5.4**	-4.5***	-2.5***	-1.7**	1.6 ns	-22.2 ns	-10.7 ns	-2.1**
2005-2009	-39.9**	-31.4**	-24.3**	-13.1*	-28.0***	-73.6*	-23.7***	-21.7**
1990-2009	-0.9 ^{ns}	-7.3***	-3.4***	-6.0***	-3.6***	-13.3***	-3.1**	-4.6***
Prod (mt)								
1990-1994	-0.7 ns	-1.5 ns	-1.2 ns	5.4*	1.7 ns	5.8 ns	1.3 ns	1.9*
1995-1999	-3.9 ns	-7.6**	-2.0**	1.0 ns	-1.8 ns	0.4 ns	1.5**	-0.7 ns
2000-2004	-0.2 ns	-4.4***	-3.3*	-1.0ns	3.0 ns	-25.3 ns	-12.7 ns	-1.7 ns
2005-2009	-42.8**	-31.0**	-13.7 ns	-14.9 ns	-21.7**	-62.7*	-15.8***	-16.9**
1990-2009	-2.8 ^{ns}	-8.9***	-3.3***	-4.7***	-2.6***	-11.6***	-2.1 ^{ns}	-4.0***
Yield (t/ac)								
1990-1994	-1.7 ns	0.8ns	-1.1 ns	5.1*	3.7**	1.8 ns	0.7 ns	2.2*
1995-1999	-0.5 ns	-7.3**	-1.9**	1.0 ns	-1.4 ns	1.5 ns	0.5 ns	-0.6 ns
2000-2004	5.2**	0.1 ns	-0.8 ns	0.7 ns	1.4***	-3.2**	-0.9**	0.4 ns
2005-2009	-3.0 ns	0.5 ns	10.6 ns	-1.8 ns	6.3***	11.0**	6.9**	4.7 ns
1990-2009	-0.9**	-1.6***	0.1 ^{ns}	1.3***	1.0***	1.7***	0.7**	0.6**

Note: '***' '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 51. Growth rates of area, production and yield of mungbean by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	-2.9***	-4.9***	-1.7 ns	-4.0**	0.5 ns	3.5 ns	1.1 ns	-3.1***
1995-1999	0.3ns	1.3**	-0.4*	2.4**	-3.1*	-10.2**	-0.2 ns	0.6**
2000-2004	-8.2**	-2.0***	-9.9***	-1.9 ns	-2.1 ns	-3.6**	-7.8**	-6.4**
2005-2009	0.5 ns	-4.6***	-19.3**	9.7***	-18.0**	-5.6 ns	-18.4**	-1.6 ns
1990-2009	-6.9***	-6.4***	-6.4***	0.0 ^{ns}	8.0***	-5.3***	-10.3***	-5.3***
Prod (mt)								
1990-1994	3.3*	-8.5*	-0.5 ns	-4.1**	-1.7 ns	10.2**	-2.2*	-0.8 ns
1995-1999	3.7 ns	1.9**	-4.3 ns	2.1 ns	-1.7 ns	-13.5**	-0.2 ns	2.0**
2000-2004	-7.4***	-0.9 ns	-7.8**	-2.6 ns	-1.2 ns	0.0ns	-9.4**	-5.4***
2005-2009	-5.1 ns	-2.8 ns	-14.5*	16.5***	-6 ns	7.9 ns	-18.5*	21.3 ns
1990-2009	-4.8***	-6.5***	-5.9***	3.1***	8.6***	-3.5***	-11.1***	-0.4 ^{ns}
Yield (t/ac)								
1990-1994	6.1***	-3.5 ns	1.2 ns	-0.1 ns	-2.2 ns	6.7***	-2.7***	2.3 ns
1995-1999	3.4 ns	0.6*	-4.0 ns	-0.3 ns	1.3 ns	-3.6 ns	0.5**	1.4 ns
2000-2004	0.7 ns	1.0 ns	2.2 ns	-0.7 ns	0.9 ns	3.6**	-1.1 ns	1.1 ns
2005-2009	-5.6*	1.8 ns	4.8*	6.7***	12.0**	13.4*	0.0 ns	22.9 ns
1990-2009	2.1***	-0.1 ^{ns}	0.6*	3.1***	0.6 ^{ns}	1.8***	-0.5**	4.9**

Note: '***' '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 52. Growth rates of area, production and yield of vetch by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	1.6***	0.8*	-1.6*	3.0***	-1.9**	11.5***	-1.3***	0.3 ns
1995-1999	-8.8***	-2.5*	1.5 ns	-2.5*	-8.5**	-12.5**	-3.8***	-3.7***
2000-2004	3.9*	-5.0***	-16.1**	-0.6 ns	-0.7 ns	2.4 ns	-26.7*	-4.8**
2005-2009	-31**	-15.2**	-4.7***	-4.7 ns	-11.0***	1.6 ns	-10.2**	-15.4***
1990-2009	-6.3***	-6.8***	-6.0***	-1.6**	-4.6***	-8.0***	-12.1***	-5.5***
Prod (mt)								
1990-1994	5.0**	3.7**	-1.5**	7.9***	3.4 ns	14.3***	-0.8 ns	1.8 ns
1995-1999	-7.4***	-0.7 ns	2.7 ns	-6.3*	-2.5 ns	14.9**	12 ns	-2.4*
2000-2004	3.7*	-5.6**	-16.1**	5.7***	-1.0 ns	8.4*	-26.5 ns	-4.3*
2005-2009	-32.4*	-24.5 ns	-2.0 ns	-10.4*	-6.3*	10.4 ns	-5.1**	-15.7**
1990-2009	-6.0***	-5.6***	-5.0***	0.4 ^{ns}	-3.2***	-6.0***	-11.2***	-4.4***
Yield (t/ac)								
1990-1994	3.4*	3.0**	0.1 ns	4.9**	5.3 ns	2.8 ns	1.3 ns	1.5 ns
1995-1999	1.4 ns	1.8*	1.2 ns	-3.8 ns	5.9 ns	-2.4 ns	12.4 ns	1.2 ns
2000-2004	-0.3 ns	-0.6 ns	0 ns	6.2***	-0.2 ns	6.0 ns	0.2 ns	0.5 ns
2005-2009	-1.4 ns	-9.3 ns	2.7 ns	0.0 ns	4.7**	8.8 ns	2.2 ns	-0.3 ns
1990-2009	0.3 ^{ns}	1.2*	1.0***	2.0***	1.4***	2.0***	0.4 ^{ns}	1.1***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 53. Growth rates of area, production and yield of chickpea by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	-4.5**	-9.0**	-5.0 ns	-3.2**	-7.5***	--	-1.7***	*** -4.3
1995-1999	-31.1 ns	-26.9 ns	-41.7 ns	-30.0 ns	-20.3 ns	--	-70.0 ns	-33.6 ns
2000-2004	10.5 ns	26.2*	0.0 ns	-9.5***	-3.5 ns	--	52.0**	-4.1***
2005-2009	-2.3 ns	-4.4**	-16.1***	-18.6**	-4.7**	--	-16.6**	-12.5**
1990-2009	-8.6***	-6.1***	-16.6***	-16.6***	-13.1***	--	-14.6***	-15.5***
Prod (mt)								
1990-1994	-9.1**	-8.2**	-7.0***	0.8 ns	-6.9**	--	-2.6**	-3.1*
1995-1999	-25.6 ns	-24.9 ns	-26.0 ns	-30.8 ns	-19.7 ns	--	-69.0 ns	-32 ns
2000-2004	5.2 ns	25.9*	1.1 ns	-7.8***	-10.6**	--	54.0***	-3.5***
2005-2009	0.9 ns	-2.4 ns	-12.9**	-17**	-0.7 ns	--	-18.4*	-10.8**
1990-2009	-7.9***	-5.2***	-17.5***	-16.2***	-12.4***	--	-13.8***	-15.0***
Yield (t/ac)								
1990-1994	-4.6**	0.8 ns	-2.0 ns	3.9 ns	0.6 ns	--	-0.9 ns	1.2 ns
1995-1999	5.4**	2.0**	15.8 ns	-0.5 ns	0.6 ns	--	0.1 ns	0.9 ns
2000-2004	-5.3*	-0.4 ns	1.1 ns	1.8 ns	-7.1 ns	--	1.8 ns	0.6 ns
2005-2009	3.2 ns	2.0 ns	3.3 ns	1.6*	4.0**	--	-0.3 ns	1.7**
1990-2009	0.7*	0.9***	-0.9 ^{ns}	0.4**	0.7*	--	0.6**	0.5***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 54. Growth rates of area, production and yield of mustard by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (acre)								
1990-1994	0.2 ns	-2.5 ns	-0.4 ns	-1.2 ns	-1.9 ns	0.8**	-0.3 ns	-1.1 ns
1995-1999	1.3 ns	1.8 ns	0.9 ns	6.4**	2.9 ns	-0.6 ns	3.6 ns	2.5*
2000-2004	-10.2***	0.3 ns	-5.4***	-1.9**	-3.7***	-3.8 ns	-10.7***	-3.9***
2005-2009	-47.5***	-15.3***	8.0**	-14.2**	-6.8 ns	-41**	-6.2 ns	0.1 ns
1990-2009	-8.0***	-8.6***	-1.9***	-1.6*	-0.6 ^{ns}	-8.1***	-3.7***	-2.3***
Prod (mt)								
1990-1994	1.3 ns	-4.6*	4.2***	1.0 ns	1.2 ns	2.8**	1.7 ns	1.5 ns
1995-1999	4.4 **	2.2 ns	0.6 ns	8.5**	3.3 ns	0.5 ns	4.9*	3.2*
2000-2004	-10.1**	1.6 ns	-5.9***	-2.3 ns	-6.1***	-5.1 ns	-9**	-4.2***
2005-2009	-47**	-11.0*	10.2*	-10.2***	11.9***	-32**	-7.5 ns	3.3 ns
1990-2009	-7.3***	-7.1***	-0.4 ^{ns}	0.3 ^{ns}	1.1*	-6.0***	-2.0**	-0.8**
Yield (t/ac)								
1990-1994	1.1 ns	-2.1 ns	4.6***	2.2*	3.1*	2 ns	2.1**	2.5**
1995-1999	3.2 **	0.4 ns	-0.2 ns	2.0**	0.4**	1.2 ns	1.0**	0.7 ns
2000-2004	0.6 ns	1.3*	-0.5 ns	-0.3 ns	-2.4*	-1.3 ns	1.3 ns	-0.3 ns
2005-2009	0.6 ns	4.3*	2.2 ns	4.05 ns	18.7*	9.5***	0.5 ns	3.2 ns
1990-2009	0.6***	1.5***	1.5***	1.8***	1.6**	2.1***	1.6***	1.5***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 55. Growth rates of area, production and yield of groundnut by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (ac)								
1990-1994	6.2**	-6.4**	-2.1 ns	-1.3 ns	9.8*	-1.0 ns	0.1 ns	-2.4*
1995-1999	0.9 ns	1.9**	-0.8 ns	-4.7 ns	-4.7***	-2.4*	-6.8 ns	-0.8*
2000-2004	-7.7*	-2.6**	-9.1***	17 ns	-3.7*	-5.4**	-16.3 ns	-6.1**
2005-2009	-13.2***	5.2 ns	1.3 ns	-10.3 ns	6.3 ns	2.9 ns	31.9**	2.2 ns
1990-2009	-2.3***	-3.1***	-1.4***	4.4**	2.6***	-1.4***	-3.2 ^{ns}	-1.6***
Prod (mt)								
1990-1994	-2.5 ns	-0.6 ns	-5.5*	-6.2**	15.5 ns	0.9 ns	0.8 ns	-0.4 ns
1995-1999	9.5 ns	1.9**	-2.2*	-2.4 ns	-6.2**	0.9 ns	-5.7 ns	-0.5 ns
2000-2004	-8.2**	0.5 ns	-6.0 ns	28.1 ns	-5.8**	-6.2**	-3 ns	-3.6 ns
2005-2009	5.3 ns	0.5 ns	4.2 ns	-21.2**	10.6**	1.8 ns	35.0**	5.1*
1990-2009	-0.8 ^{ns}	-0.4 ^{ns}	-0.6 ^{ns}	8.0***	1.1 ^{ns}	0.8 ^{ns}	-2.1 ^{ns}	0.0 ^{ns}
Yield (t/ac)								
1990-1994	-8.7 ns	5.8*	-3.3*	-4.9 ns	5.7 ns	1.9 ns	-22.9 ns	2.0**
1995-1999	8.6 ns	0.0 ns	-1.4*	2.3 ns	-1.4 ns	3.4 ns	4.8*	0.3 ns
2000-2004	-0.5 ns	3.1***	3.0 ns	11.1***	-2.1 ns	-0.8 ns	4.0 ns	2.6 ns
2005-2009	18.4**	-4.7 ns	2.9 ns	-10.9*	4.3 ns	-1.1 ns	5.9*	2.9*
1990-2009	1.4*	2.7***	0.8 ^{ns}	3.6***	-1.5***	2.2***	-0.3 ^{ns}	1.5***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 56. Growth rates of area, production and yield of onion by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (ac)								
1990-1994	2.5 ns	-2.0**	-1.1*	0.4 ns	-1.7***	2.3*	1.9***	-0.6 ns
1995-1999	-3.1*	-1.2*	-0.3 ns	-0.3 ns	-1.7 ns	2.4 ns	1.7 ns	-0.4 ns
2000-2004	0.8 ns	-2.1 ns	8.6 ns	13.5*	16.5**	-4.7**	-2.0**	9.6*
2005-2009	-5.0 ns	5.2**	5.6 ns	0.1 ns	7.3 ns	6.5*	6.2**	5.2 ns
1990-2009	-0.7*	-1.1***	6.1***	8.1***	10.4***	-4.5***	2.9***	7.0***
Prod (mt)								
1990-1994	4.5**	-2.3*	-7.7 ns	-1.5 ns	1.3 ns	7.5***	-0.4 ns	-0.7 ns
1995-1999	-3.6 ns	0.9 ns	-1.1 ns	-5.3**	-1.4 ns	8.1**	0.3 ns	-1.6 ns
2000-2004	-1.4 ns	-1.6 ns	15.1 ns	21.3**	24.4*	-5.5 ns	-3.6**	16.0*
2005-2009	3.8 ns	6.5**	3.5 ns	6.9 ns	6.0 ns	9.8**	17.6**	5.9 ns
1990-2009	-0.5 ^{ns}	0.9 ^{ns}	8.9***	11.3***	14.2***	-0.6 ^{ns}	3.3***	10.0***
Yield (t/ac)								
1990-1994	1.9 ns	-0.3 ns	-6.7 ns	-1.9 ns	3.0*	5.1**	1.8*	-0.2 ns
1995-1999	-0.5 ns	2.1 ns	-0.8*	-5.0**	0.4 ns	5.7**	-1.6**	-1.2**
2000-2004	-2.2*	0.6 ns	6.5 ns	7.8**	7.9 ns	-0.8 ns	-1.6**	6.5 ns
2005-2009	8.8**	1.3 ns	-2.1 ns	6.8*	-1.2 ns	3.4 ns	12**	0.7 ns
1990-2009	0.2 ^{ns}	2.0***	2.7***	3.2***	3.8***	3.9***	0.4 ^{ns}	3.0***

Note: '***' '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 57. Growth rates of area, production and yield of garlic by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (ac)								
1990-1994	0.7**	0.2 ns	-1.3**	1.3 ns	-2.9**	7.9*	2.0*	-0.3 ns
1995-1999	-2.4 ns	2.5***	0.1 ns	-1.2 ns	1.4***	5.5**	1.0**	0.5*
2000-2004	7.8***	0.7*	4.0*	6.2 ns	25.8*	-10.6 ns	3.7***	9.7*
2005-2009	3.8**	3.0 ns	9.4**	3.5 ns	11 ns	-15.4*	5.1**	8.2*
1990-2009	1.9***	0.7***	3.0***	4.5***	12.2***	-3.3**	3.5***	5.1***
Prod (mt)								
1990-1994	0.3 ns	0.3 ns	0.1 ns	2.8 ns	-7.8**	14.4***	8.2 ns	1.0 ns
1995-1999	-8.5**	-0.2 ns	0.2 ns	-1.9 ns	0.3 ns	-0.4 ns	0.3 ns	-0.5 ns
2000-2004	9.4***	1.0***	7.5 ns	7.7 ns	33.0*	-9.9*	3.2**	13.2 ns
2005-2009	2.9*	5.2*	10.7***	18.0 ns	18.5 ns	-15.3*	14.0*	14.3 ns
1990-2009	0.6 ^{ns}	1.1**	3.4***	6.9***	14.7***	-2.8**	5.0***	7.4***
Yield (t/ac)								
1990-1994	-0.4 ns	0.1 ns	1.5 ns	1.5 ns	-4.9*	6.4 ns	5.4 ns	1.3**
1995-1999	-6.1**	-2.7*	0.1 ns	-0.8 ns	-1.1 ns	-5.8***	-0.7 ns	-0.1*
2000-2004	1.7**	0.3 ns	3.6 ns	1.5 ns	7.3**	0.7 ns	-0.7 ns	3.5 ns
2005-2009	-0.9 ns	2.2 ns	1.3 ns	14.5 ns	7.4*	0.1 ns	8.3 ns	6.0 ns
1990-2009	-1.4***	0.4 ^{ns}	0.4 ^{ns}	2.4***	2.5***	0.5 ^{ns}	1.3**	2.3***

Note: '***' '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 58. Growth rates of area, production and yield of chilli by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (ac)								
1990-1994	-1.16 ns	-1.5**	-1.4*	-0.8 ns	-1.7*	-0.2 ns	-0.3 ns	-2.5**
1995-1999	19.5 ns	16.0 ns	24.4 ns	19.5 ns	13.3 ns	23.7 ns	25.2 ns	19.4 ns
2000-2004	-0.4***	-0.1 ns	-2.9*	1.5 ns	-7.8**	-0.3***	-4.6 ns	-1.8**
2005-2009	-22.4*	-20.4**	-14.3**	-7.7**	-2.8*	-43.2**	-4.3**	-15.1**
1990-2009	3.6**	3.1**	6.1***	6.5***	1.0 ^{ns}	4.0 ^{ns}	4.1**	4.0***
Prod (mt)								
1990-1994	-2.67 ns	3.8*	-0.5 ns	-2.0 ns	-0.4 ns	8.4*	-3.4 ns	1.4 ns
1995-1999	22.6 ns	15.8 ns	25.5 ns	18.6 ns	13.0 ns	27.3 ns	25.2 ns	19.9 ns
2000-2004	1.8 ns	-0.2 ns	-2.0 ns	8.6 ns	-9.0*	0.0 ns	-1.7*	-0.9 ns
2005-2009	-26.4**	-23.1**	-15.7***	6.7 ns	2.5 ns	-45.1*	-10.8***	-13.4***
1990-2009	5.1***	5.7***	8.2***	12.6***	3.5***	7.3***	6.6***	6.6***
Yield (t/ac)								
1990-1994	-1.5 ns	5.3*	0.9 ns	-1.2 ns	1.3 ns	8.5*	-0.8 ns	3.8**
1995-1999	3.13*	-0.3 ns	1.2 ns	-0.9**	-0.4*	3.5***	0.2 ns	0.5 ns
2000-2004	2.2 ns	-0.2 ns	0.8 ns	7.1 ns	-1.2 ns	0.3 ns	2.8 ns	1.0 ns
2005-2009	-3.6 ns	-2.7 ns	-1.4 ns	14.4*	5.2 ns	-1.9 ns	-6.0**	1.8 ns
1990-2009	1.5***	2.6***	2.1***	6.1***	2.4***	3.2***	2.4***	2.6***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 59. Growth rates of area, production and yield of ginger by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (ac)								
1990-1994	23.2**	0.6***	1.2**	1.8 ns	-0.6 ns	-1.8 ns	-1.0 ns	0.2 ns
1995-1999	-28.8**	-0.5**	1.1**	2.3**	-2.1 ns	-5.0***	-0.2 ns	-0.1 ns
2000-2004	44.1***	6.3***	3.4*	-3.0**	-1.6 ns	-3.5 ns	0.1 ns	3.1***
2005-2009	0.0 ns	12.2 ns	2.1 ns	-1.4 ns	1.3 ns	-8.4 ns	9.1***	4.7**
1990-2009	-0.7 ^{ns}	3.1***	2.2***	0.5*	1.3***	-4.9***	0.1 ^{ns}	1.3***
Prod (mt)								
1990-1994	20.8*	0.2 ns	0.7 ns	3.0**	-1.7 ns	-4.1 ns	-4.8***	-1.5**
1995-1999	-22.9*	-1.1 ns	0.8 ns	0.9 ns	-0.5 ns	-5.2***	-1.4***	-22.2 ns
2000-2004	43.6***	8.9***	2.9 ns	-0.7 ns	0.5 ns	-7.8**	1.2 ns	4.8**
2005-2009	0.0 ns	7.5*	9.0 ns	4.0*	3.7**	0.3 ns	20.2***	10.7**
1990-2009	2.3 ^{ns}	4.0***	3.5***	4.1***	3.1***	-4.9***	0.7 ^{ns}	2.8**
Yield (t/ac)								
1990-1994	-2.4*	-0.4 ns	-0.5*	1.3 ns	-1.2 ns	-2.3 ns	-2.3**	-1.7**
1995-1999	5.9 ns	-0.7 ns	-0.3***	-1.4*	1.6 ns	-0.2 ns	-1.2**	-22.1 ns
2000-2004	-1.1 ns	2.7 ns	-0.5 ns	2.3*	2.1*	-4.3 ns	1.9 ns	1.7 ns
2005-2009	-	-4.7 ns	6.9 ns	5.4 ns	2.5*	8.7 ns	14.1**	6.0**
1990-2009	3.0**	0.9 ^{ns}	1.3***	3.6***	1.8***	0.0 ^{ns}	1.8**	1.5 ^{ns}

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 60. Growth rates of area, production and yield of turmeric by division, 1990-2009

Year	Barisal	Chittagong	Dhaka	Khulna	Rajshahi	Sylhet	Rangpur	Bangladesh
Area (ac)								
1990-1994	3.8**	-1.4***	-1.3**	4.4 ns	-3.7 ns	5.4 ns	-2.7*	-0.4**
1995-1999	-1.3 ns	1.7**	1.9**	-0.4 ns	-3.8***	2.9***	-0.3 ns	-0.2 ns
2000-2004	-3.1**	6.7**	2.7*	3.8 ns	3.6*	-2.4 ns	0.2 ns	3.5*
2005-2009	6.7 ns	2.6 ns	5.8*	8.0*	5.0**	-5.4***	4.8**	4.9***
1990-2009	-0.1 ^{ns}	3.1***	2.3***	2.7***	0.3 ^{ns}	0.5 ^{ns}	0.3 ^{ns}	1.7***
Prod (mt)								
1990-1994	4.2*	-2.1**	-5.2 ns	12.8***	0.9 ns	8.3**	15.8 ns	2.6***
1995-1999	-0.8 ns	4.5**	0.5 ns	2.5 ns	-4.8***	-4.8**	-1.2 ns	0.9 ns
2000-2004	-1.3 ns	12.5**	0.8 ns	17.2 ns	13.2**	27.4 ns	3.9 ns	11.8*
2005-2009	-1.6 ns	7.3**	15.7*	17.2**	14.6***	4.5 ns	17.6 ns	13.4***
1990-2009	-0.9**	6.5***	3.3***	9.5***	3.4***	9.0***	3.5**	6.2***
Yield (t/ac)								
1990-1994	0.4 ns	-0.6 ns	-3.9 ns	8.4***	4.6 ns	2.9 ns	24.4 ns	3.1***
1995-1999	0.5 ns	2.8**	-1.3 ns	2.9*	-1.0**	-7.7***	0.2 ns	1.0 ns
2000-2004	1.8 ns	5.8*	-2.0 ns	13.4 ns	9.6 ns	29.8 ns	2.3 ns	8.3*
2005-2009	-8.3 ns	4.7*	9.8*	9.2***	9.5**	10.0 ns	14.8 ns	8.5***
1990-2009	-0.8 ^{ns}	3.5***	0.9 ^{ns}	6.8***	3.1***	8.5***	2.8*	4.5***

Note: '***', '**' and '*' represent 1%, 5% and 10% level of significant; 'ns' represent non-significant

Table 61. Growth rate of area, production and yield of different cereal crops, 1990-2009

Time period	Bangladesh			India			Pakistan		
	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield
Rice									
1990-1994	-1.35***	-1.40 ^{ns}	0.0 ^{ns}	0.0 ^{ns}	2.6*	2.6***	0.5 ^{ns}	3.2 ^{ns}	2.6 ^{ns}
1995-1999	1.39*	5.8***	4.4***	1.4***	3.6***	2.2***	3.8***	6.1***	2.3**
2000-2004	-0.99 ^{ns}	-0.2 ^{ns}	0.80 ^{ns}	-1.8 ^{ns}	-1.0 ^{ns}	0.90 ^{ns}	2.7 ^{ns}	3.1 ^{ns}	0.50 ^{ns}
2005-2009	2.15***	5.0***	2.8***	-0.90 ^{ns}	0.1 ^{ns}	1.0 ^{ns}	3.3 ^{ns}	6.8**	3.5***
Over all	0.50***	3.4***	2.9***	0.1 ^{ns}	1.2***	1.2***	1.6***	3.6***	2.0***
Wheat									
1990-1994	1.4 ^{ns}	6.4***	5.0*	1.5 ^{ns}	4.0***	2.5*	1.0 ^{ns}	2.3 ^{ns}	1.3 ^{ns}
1995-1999	7.8***	11***	3.4**	2.0*	2.3 ^{ns}	0.3 ^{ns}	0.10 ^{ns}	2.0 ^{ns}	1.9 ^{ns}
2000-2004	-6.1***	-8.7***	-2.6*	-0.9 ^{ns}	-1.7 ^{ns}	-0.9 ^{ns}	-0.8 ^{ns}	-1.5 ^{ns}	-0.7 ^{ns}
2005-2009	-9.1**	-1.4 ^{ns}	7.7*	1.6*	4.5***	2.9***	1.7***	2.0 ^{ns}	0.3 ^{ns}
Over all	-1.9**	-1.2 ^{ns}	0.7 ^{ns}	0.8***	1.9***	1.1***	0.4***	2.4***	2.0***
Maize									
1990-1994	-2.3 ^{ns}	-4.8*	-2.5***	1.0***	1.6 ^{ns}	0.5 ^{ns}	1.4***	2.2*	0.8 ^{ns}
1995-1999	9.4 ^{ns}	9.0*	-0.6 ^{ns}	1.3 ^{ns}	4.1***	2.9***	0.8*	3.0**	2.2***
2000-2004	50.4***	69***	19***	3.4***	4.6 ^{ns}	1.2 ^{ns}	0.8 ^{ns}	11.9**	11.1**
2005-2009	21.3*	23.8 ^{ns}	2.5 ^{ns}	2.2***	5.2 ^{ns}	2.9 ^{ns}	-1.8 ^{ns}	2.5 ^{ns}	4.3***
Over all	25.0***	38***	12***	2***	4.1***	2.1***	0.9***	6.3***	5.4***

Note: Area in hectare, production in metric ton and yield in ton per ha, '***', '**' and '*' indicate significant at 1%, 5% and 10% level respectively

Table 62. Growth rate of area, production and yield of different fruits, 1990-2009

Time period	Bangladesh			India			Pakistan		
	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield
Pineapple							--	--	--
1990-1994	0.1 ^{ns}	-1.8 ^{ns}	-1.9 ^{ns}	4.3 ^{ns}	5.4 ^{ns}	1.1 ^{ns}	--	--	--
1995-1999	-0.2*	-0.4*	-0.3 ^{ns}	-3.1 ^{ns}	-3.5 ^{ns}	-0.4 ^{ns}	--	--	--
2000-2004	3.5 ^{ns}	7.4 ^{ns}	3.9*	4.1 ^{ns}	4.5 ^{ns}	0.5 ^{ns}	--	--	--
2005-2009	-3.9***	-2.4 ^{ns}	1.5 ^{ns}	0.0 ^{ns}	0.8 ^{ns}	0.8*	--	--	--
Over all	1.2***	2.6***	1.4***	1.9***	2.3***	0.5 ^{ns}	--	--	--
Papaya									
1990-1994	6.3***	6.3***	0.0 ^{ns}	12***	26***	14**	4***	5.5***	1.5*
1995-1999	2.0***	1.5*	-0.5 ^{ns}	0.4 ^{ns}	6.5**	6.1**	16**	0.7 ^{ns}	-15***
2000-2004	5.1***	5***	-0.1 ^{ns}	-1.4 ^{ns}	2.6 ^{ns}	4.0 ^{ns}	-1.2 ^{ns}	2.8 ^{ns}	4.0 ^{ns}
2005-2009	4.1 ^{ns}	-12 ^{ns}	-16**	11***	15***	4.6***	-3.7**	-1.4 ^{ns}	2.3 ^{ns}
Over all	9.5***	8.1***	-1.5**	3.5***	8.3***	4.8***	4.7***	1.5***	-3.2***
Banana									
1990-1994	0.2 ^{ns}	0.6***	0.4 ^{ns}	5.1***	10***	5.3***	2.1 ^{ns}	-15.1 ^{ns}	-17.2 ^{ns}
1995-1999	-0.2*	-2.6 ^{ns}	-2.3 ^{ns}	3.2***	13***	10***	3.1***	9.8**	6.8**
2000-2004	4.5***	4.9***	0.4 ^{ns}	5.2**	3.1 ^{ns}	-2.1 ^{ns}	1.7 ^{ns}	1.5 ^{ns}	-0.2 ^{ns}
2005-2009	-0.6 ^{ns}	-1.8 ^{ns}	-1.2 ^{ns}	7.6***	9***	1.3 ^{ns}	1.7 ^{ns}	-0.6 ^{ns}	-2.3 ^{ns}
Over all	2.2***	2.1***	-1.0 ^{ns}	3.2***	6.2***	3.0***	5.0***	4.9***	0.0 ^{ns}
Mango									
1990-1994	0.4***	1.2**	0.8 ^{ns}	8.7**	6.2***	-2.5 ^{ns}	0.5 ^{ns}	2.1**	1.5 ^{ns}
1995-1999	0.3***	-0.2 ^{ns}	-0.5*	2.6 ^{ns}	-3.9*	-6.4 ^{ns}	1.5***	0.8*	-0.7 ^{ns}
2000-2004	0.2 ^{ns}	7.8**	7.6**	5.6**	4.2 ^{ns}	-1.5 ^{ns}	2.4***	2.8***	0.4 ^{ns}
2005-2009	8.1***	8***	-0.1 ^{ns}	4.1***	3.6**	-0.6 ^{ns}	3.3***	0.6 ^{ns}	-2.7**
Over all	6.3***	8.3***	2.0***	4.4***	1.9***	-2.5***	6.3***	4.7***	0.7***

Note: Area in hectare, production in metric ton and yield in ton per ha. '***', '**' and '*' indicate significant at 1%, 5% and 10% level respectively

Table 63. Growth rate of area, production and yield of pulses and oilseeds, 1990-2009

Time period	Bangladesh			India			Pakistan		
	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield
All Pulses									
1990-1994	-0.8***	0.7 ^{ns}	1.4**	-2 ^{ns}	-0.7 ^{ns}	1.2 ^{ns}	-3.1**	-8.5**	-5.4*
1995-1999	-8.2**	-7.2*	1.1 ^{ns}	-1**	0.2 ^{ns}	1.4 ^{ns}	-1.2**	2.4 ^{ns}	3.4 ^{ns}
2000-2004	-4.8**	-4.3***	0.4 ^{ns}	4.9**	0.2 ^{ns}	-4.6**	-0.1 ^{ns}	3.7 ^{ns}	3.7 ^{ns}
2005-2009	-13***	-12***	1.8 ^{ns}	-1 ^{ns}	1.9 ^{ns}	3.3**	0.2 ^{ns}	-1.2 ^{ns}	-1.4 ^{ns}
Over all	-6.2***	-5.1***	1.1***	-0.2 ^{ns}	0.3 ^{ns}	0.6**	-0.8***	0.3 ^{ns}	1.1**
Lentil									
1990-1994	-0.3*	2.0*	2.3**	1.4 ^{ns}	0.4 ^{ns}	-1.2 ^{ns}	-5.5*	-3.2 ^{ns}	2.4 ^{ns}
1995-1999	-4.4 ^{ns}	-5.4 ^{ns}	-1.0 ^{ns}	3.9*	4.8 ^{ns}	0.8 ^{ns}	-1.2 ^{ns}	4.7***	5.8*
2000-2004	-2.2***	-1.8 ^{ns}	0.2 ^{ns}	-1.5 ^{ns}	-1.2 ^{ns}	0.2 ^{ns}	-0.6 ^{ns}	-1.8 ^{ns}	-1.3 ^{ns}
2005-2009	-21.0**	-18.0**	2.9 ^{ns}	-2.7 ^{ns}	-2.5 ^{ns}	0.1 ^{ns}	-7.9*	-13.0**	-5.9**
Over all	-4.5***	-3.9***	0.7**	1.3***	1.3***	0.0 ^{ns}	-3.8***	-2.8***	1.0**
Oilseeds									
1990-1994	0.0 ^{ns}	2.2 ^{ns}	2.2 ^{ns}	1.9 ^{ns}	4.6**	2.7 ^{ns}	0.0 ^{ns}	-4.9 ^{ns}	-5.0 ^{ns}
1995-1999	-2.7*	-1.0 ^{ns}	1.6***	-0.5 ^{ns}	-3.0 ^{ns}	-2.4 ^{ns}	-0.1 ^{ns}	2.8 ^{ns}	2.8 ^{ns}
2000-2004	-2.3***	-1.5*	0.7 ^{ns}	0.7 ^{ns}	3.9 ^{ns}	3.2 ^{ns}	2.1 ^{ns}	7.1 ^{ns}	5.0 ^{ns}
2005-2009	1.2 ^{ns}	2.5 ^{ns}	1.3 ^{ns}	0.5 ^{ns}	-0.4 ^{ns}	-0.9 ^{ns}	-1.1 ^{ns}	-1.4 ^{ns}	-0.3 ^{ns}
Over all	-2.8***	-1.5***	1.3***	0.5**	1.5***	0.9***	1***	2.8***	1.9***

Note: Area in hectare, production in metric ton and yield in ton per ha. '***', '**' and '*' indicate significant at 1%, 5% and 10% level respectively

Table 64. Growth rate of area, production and yield of spices, 1990-2009

Time period	Bangladesh			India			Pakistan		
	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield
All Spices									
1990-1994	-0.7*	2.0**	2.7***	5.7*	12*	7.2*	4.8 ^{ns}	12.0***	8.0***
1995-1999	0.0 ^{ns}	0.7 ^{ns}	0.6 ^{ns}	1.9 ^{ns}	7.7***	5.8 ^{ns}	-0.7**	-1.2 ^{ns}	-0.5 ^{ns}
2000-2004	4.0***	10.0 ^{ns}	6.3 ^{ns}	-0.8 ^{ns}	1.2 ^{ns}	2.1 ^{ns}	10.0 ^{ns}	-0.7 ^{ns}	-11.0 ^{ns}
2005-2009	6.0***	13***	7.1**	2.5 ^{ns}	-0.4 ^{ns}	-3.0**	-6.2**	1.1 ^{ns}	7.2**
Over all	2.0***	5.9***	3.9***	0.0 ^{ns}	3.1***	3.2***	4.9***	1.7***	-3.2**
Garlic									
1990-1994	-0.3 ^{ns}	0.8 ^{ns}	1.1*	-0.3 ^{ns}	0.9 ^{ns}	1.2 ^{ns}	9.8***	11.0***	1.6***
1995-1999	0.0 ^{ns}	2.1 ^{ns}	2.1 ^{ns}	3.9 ^{ns}	3.5 ^{ns}	-0.4 ^{ns}	0.5 ^{ns}	0.5 ^{ns}	0.0 ^{ns}
2000-2004	9.9*	10.0 ^{ns}	0.9 ^{ns}	1.4 ^{ns}	4.7 ^{ns}	3.2 ^{ns}	-5.8**	-7.0**	-1.2 ^{ns}
2005-2009	8.2 ^{ns}	14.0 ^{ns}	6.1**	7.1 ^{ns}	10.0 ^{ns}	3.7**	6.2***	4.8***	-1.5*
Over all	5.6***	7.5***	1.9***	3.7***	4.8***	1.1***	0.2 ^{ns}	-0.3 ^{ns}	-0.5***
Chilies									
1990-1994	--	--	--	0.7***	1.2***	0.5**	--	--	--
1995-1999	--	--	--	2.8***	4.2**	1.5 ^{ns}	--	--	--
2000-2004	--	--	--	1.7 ^{ns}	-3.5 ^{ns}	-5.2*	--	--	--
2005-2009	--	--	--	4.1***	5.8***	1.7**	--	--	--
Over all	--	--	--	2.0***	1.3***	-0.9***	--	--	--

Note: Area in hectare, production in metric ton and yield in ton per ha. '***', '**' and '*' indicate significant at 1%, 5% and 10% level respectively

Table 65. Growth rate of area, production and yield of vegetables, 1990-2009

Time period	Bangladesh			India			Pakistan		
	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield
All vegetables									
1990-1994	2.7**	1.8***	-0.9 ^{ns}	-1.8 ^{ns}	2.6***	4.4**	3.4***	4.2***	0.8**
1995-1999	5.5*	4.1**	-1.5 ^{ns}	-0.4 ^{ns}	5.8*	6.2***	2.6***	2.7**	0.1 ^{ns}
2000-2004	3.1**	3.2 ^{ns}	0.2 ^{ns}	1.5 ^{ns}	-1.9 ^{ns}	-3.4 ^{ns}	0.8 ^{ns}	-0.6 ^{ns}	-1.4***
2005-2009	4.8**	7.5***	2.7***	3.7**	5.9**	2.3**	1.8 ^{ns}	1.0 ^{ns}	-0.8**
Over all	4.2***	5.0***	0.8***	2.1***	3.4***	1.3***	2.7***	2.6***	-0.1 ^{ns}
Cauliflower									
1990-1994	2.2**	2.4**	0.1 ^{ns}	-1.4 ^{ns}	1.7 ^{ns}	3.1 ^{ns}	5.7***	7.1**	1.4 ^{ns}
1995-1999	3.1***	1.4 ^{ns}	-1.7 ^{ns}	0.1 ^{ns}	3.1 ^{ns}	3*	2**	2.0***	0.0 ^{ns}
2000-2004	3.7**	5.4*	1.7 ^{ns}	2.1 ^{ns}	1.1*	-1 ^{ns}	1.6***	0.8*	-0.8**
2005-2009	5.1***	9.4***	4.3**	8.4***	8.2***	-0.2 ^{ns}	3.1**	2.9**	-0.2 ^{ns}
Over all	3.4***	4.5***	1.1***	1.9***	3.0***	1.1***	2.3***	2.7***	0.4***
Potatoes									
1990-1994	2.8***	7.1**	4.3**	5.0 ^{ns}	5.2*	0.2 ^{ns}	0.4 ^{ns}	7.0*	6.6***
1995-1999	12.0 ^{ns}	13.0 ^{ns}	0.3 ^{ns}	4.5**	4.5 ^{ns}	0.0 ^{ns}	9.3***	12.0 ^{ns}	3.5 ^{ns}
2000-2004	2.0 ^{ns}	6.3*	4.3**	3.0 ^{ns}	2.6 ^{ns}	-0.4 ^{ns}	1.2 ^{ns}	2.3 ^{ns}	1.1 ^{ns}
2005-2009	4.6*	3.8 ^{ns}	-0.8 ^{ns}	5.0***	5.3*	0.3 ^{ns}	7.9**	12.3 ^{ns}	4.4 ^{ns}
Over all	7.3***	9.8***	2.5***	3.1***	4.1***	1.0***	3.7***	6.6***	2.9***

Note: Area in hectare, production in metric ton and yield in ton per ha. '***', '**' and '*' indicate significant at 1%, 5% and 10% level respectively

Table 66. Growth rate of production and yield of different livestock products, 1990-2009

Time period	Bangladesh			India			Pakistan		
	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield
Egg									
1990-1994	--	6.6***	0.2 ^{ns}	--	5.1***	3.6**	--	5.5**	0.2 ^{ns}
1995-1999	--	6.8 ^{ns}	0.1 ^{ns}	--	3.1***	-0.1 ^{ns}	--	2.9 ^{ns}	-0.3 ^{ns}
2000-2004	--	6.8***	-0.4 ^{ns}	--	4.6***	-0.1 ^{ns}	--	2.6***	-3.2**
2005-2009	--	-3.2 ^{ns}	-2.3***	--	6.1***	3.2***	--	6.4***	0.6**
Over all	--	6.2***	0.0 ^{ns}	--	5.6***	1.0***	--	4.6***	-0.2*
Milk									
1990-1994	--	4.4***	-1.2***	--	3.5***	2.2***	--	5***	2.4***
1995-1999	--	1.2 ^{ns}	-0.5 ^{ns}	--	4.4***	2.6**	--	5.9**	1.7**
2000-2004	--	4***	-0.9***	--	3.1***	1 ^{ns}	--	2.8***	1.7**
2005-2009	--	5.2***	-1***	--	3.9***	2.8***	--	3.7***	1.4 ^{ns}
Over all	--	3.3***	-0.8***	--	3.9***	2.4***	--	4.4***	1.9***
Poultry meat									
1990-1994	--	5.2***	-0.3***	--	2.8***	0.0 ^{ns}	--	18.0**	6.3 ^{ns}
1995-1999	--	0.7 ^{ns}	-0.3 ^{ns}	--	4.4 ^{ns}	0.9 ^{ns}	--	-2.1 ^{ns}	3.0**
2000-2004	--	6.1***	-0.2 ^{ns}	--	6.0 ^{ns}	-0.8 ^{ns}	--	3.8***	-2.3**
2005-2009	--	4.3***	-0.2***	--	9.0***	-0.7 ^{ns}	--	12.0***	1.6 ^{ns}
Over all	--	4.4***	-0.2***	--	7.1***	1.8***	--	6.1***	0.3 ^{ns}
Beef									
1990-1994	--	1.3***	0.2 ^{ns}	--	0.9***	0.5**	--	4.8***	2.6***
1995-1999	--	3.4**	3.8***	--	0.3***	0.2***	--	2.1 ^{ns}	0.3 ^{ns}
2000-2004	--	1.3***	-0.2 ^{ns}	--	0.6**	0.2***	--	2.5***	-0.3 ^{ns}
2005-2009	--	0.8***	0.2*	--	1.8***	0.0 ^{ns}	--	7.8**	0.4***
Over all	--	1.8***	1.0***	--	0.7***	0.1**	--	3.6***	0.2***
Mutton									
1990-1994	--	7.2***	--	--	1.4***	--	--	6.9***	2.2**
1995-1999	--	4.7**	--	--	1.1***	--	--	7.8 ^{ns}	-1.5 ^{ns}
2000-2004	--	5.3***	--	--	1.1**	--	--	2.6***	0.6***
2005-2009	--	7.2***	--	--	3.3***	--	--	-4.1 ^{ns}	-0.4 ^{ns}
Over all	--	5.4***	--	--	1.2***	--	--	-1.4*	-0.2**

Note: Production in metric ton and yield in ton/Animal

‘***’, ‘**’ and ‘*’ indicate significant at 1%, 5% and 10% level respectively

Table 67. Growth rate of production of fisheries, 2000-2009

Time period	Bangladesh			India			Pakistan		
	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield	Area	Prod ⁿ	Yield
Inland									
2000-2004	--	4.0***	--	--	-1.7 ^{ns}	--	--	-5.9***	--
2005-2009	--	7.0***	--	--	2.5**	--	--	3.8 ^{ns}	--
Over all	--	6.3***	--	--	1.1**	--	--	-2.1*	--
Culture									
2000-2004	--	8.5***	--	--	8.2**	--	--	38.7*	--
2005-2009	--	5.0***	--	--	6.8**	--	--	11.8*	--
Over all	--	4.7***	--	--	7.9***	--	--	19.7***	--

Note: Production in metric ton, Growth rates of fisheries have been calculated for 2000 to 2009 due to non availability of data. ‘***’, ‘**’ and ‘*’ indicate significant at 1%, 5% and 10% level respectively

Table 68. Status of agricultural diversification index (ADI) in Bangladesh

Year	Barisal	Chittagong	Sylhet	Dhaka	Khulna	Rajshahi	Rangpur	Bangladesh
1992-93	0.56	0.58	0.51	0.56	0.53	0.43	0.35	0.51
1993-94	0.58	0.62	0.54	0.58	0.58	0.48	0.37	0.54
1994-95	0.61	0.57	0.45	0.54	0.55	0.44	0.34	0.51
1995-96	0.61	0.60	0.45	0.59	0.55	0.49	0.35	0.54
1996-97	0.70	0.64	0.49	0.57	0.61	0.49	0.40	0.57
1997-98	0.71	0.64	0.46	0.58	0.63	0.47	0.38	0.55
1998-99	0.63	0.62	0.47	0.57	0.56	0.45	0.40	0.53
1999-00	0.65	0.64	0.53	0.54	0.57	0.47	0.41	0.54
2000-01	0.65	0.63	0.53	0.54	0.60	0.47	0.41	0.55
2001-02	0.66	0.64	0.51	0.53	0.59	0.48	0.42	0.55
2002-03	0.58	0.60	0.47	0.48	0.55	0.47	0.39	0.51
2003-04	0.65	0.64	0.55	0.56	0.61	0.54	0.46	0.57
2004-05	0.60	0.66	0.50	0.59	0.57	0.49	0.40	0.56
2005-06	0.64	0.67	0.53	0.58	0.60	0.56	0.42	0.58
2006-07	0.76	0.75	0.65	0.66	0.69	0.63	0.49	0.66
2007-08	0.65	0.65	0.54	0.57	0.56	0.52	0.43	0.56
2008-09	0.62	0.70	0.58	0.61	0.61	0.59	0.46	0.60
2009-10	0.60	0.66	0.52	0.58	0.59	0.60	0.46	0.58

Note: Calculated using BBS secondary data

Table 69. Status of agricultural diversification in India and Pakistan

(Value in Million USD)

Year	India				Pakistan			
	Value of cereals	Value of non-cereals	Value of total Agric.	ADI	Value of cereals	Value of non-cereals	Value of total Agric.	ADI
1993	25735	38766	64501	0.60	3503	13267	16770	0.79
1994	26413	43410	69823	0.62	3459	14430	17889	0.81
1995	28115	48008	76123	0.63	3895	16195	20090	0.81
1996	30255	49431	79686	0.62	4251	16496	20747	0.80
1997	26533	50564	77097	0.66	4541	15968	20509	0.78
1998	26262	46448	72710	0.64	4501	16287	20788	0.78
1999	31357	47884	79241	0.60	4305	14888	19193	0.78
2000	29538	46065	75603	0.61	4643	14965	19608	0.76
2001	28462	48177	76639	0.63	3414	13384	16798	0.80
2002	24674	47054	71728	0.66	4047	15192	19239	0.79
2003	29295	56086	85381	0.66	4644	16855	21499	0.78
2004	39080	58964	98044	0.60	5646	18621	24267	0.77
2005	42868	66281	109149	0.61	6345	19036	25381	0.75
2006	52191	73426	125617	0.58	6234	20977	27211	0.77
2007	71991	91837	163828	0.56	6932	23047	29979	0.77
2008	80697	98214	178911	0.55	6327	21540	27867	0.77
2009	73367	95253	168620	0.56	11130	25981	37111	0.70
2010	78667	105518	184185	0.57	10047	31167	41214	0.76

Note: Calculated using FAOstat data

Table 70. Summary statistics of variables used in probit regression model

Variable	Obs	Mean	Std. Dev.	Min	Max
Agricultural diversification index (ADI)	960	0.624677	0.333767	0	1
Irrigated land (decimal)	960	175.0406	241.2889	0	270 6
Land suitability dummy (if suitable 1, otherwise 0)	960	0.844792	0.362292	0	1
No. of training received	960	1.852083	2.874322	0	25
Extension linkage (weighted score)	960	10.60208	5.688654	0	35
Family influence in production (scale, 0-4)	960	1.785417	1.627384	0	4
Credit facility dummy (if yes =1, otherwise 0)	960	0.417708	0.493439	0	1
Storage facility dummy (if yes =1, otherwise 0)	960	0.481250	0.499909	0	1
Access to market (km)	960	2.050245	1.736469	0	13

Table 71. Summary statistics of variables used in GLS regression model

Explanatory variable	Mean	Std.Dev.	Min.	Max	Obs
1. ADI value					
• Overall	0.576265	0.128616	0.311	0.944	N =230 n = 23 T = 10
• Between		0.11958	0.386	0.845	
• Within		0.05296	0.4131652	0.811165	
2. Real wage rate (Tk/day)					
• Overall	0.108502	0.020729	0.0676359	0.19221	N =230 n = 23 T = 10
• Between		0.017035	0.0771343	0.151224	
• Within		0.012286	0.0843219	0.152212	
3. Real wage rate square					
• Overall	0.012201	0.004821	0.0045746	0.036945	N =230 n = 23 T = 10
• Between		0.003868	0.0060368	0.023171	
• Within		0.002978	0.0057938	0.025974	
4. Per capita road length (km)					
• Overall	0.00024	0.000289	0.0000162	0.001707	N =207 n = 23 T = 9
• Between		0.000289	0.0000253	0.001398	
• Within		5.73E-05	-0.0002336	0.00055	
5. Per capita road length square					
• Overall	1.41E-07	4.34E-07	2.64E-10	2.92E-06	N =207 n = 23 T = 9
• Between		4.22E-07	6.99E-10	2.01E-06	
• Within		1.32E-07	-1.01E-06	1.05E-06	
6. Rainfall (mm)					
• Overall	2216.704	692.723	792	4939	N = 203 n = 23 T = 8.83
• Between		579.0889	1402.111	3968.778	
• Within		393.9439	1396.038	3754.149	
Agril. credit disbursement (Lac Tk)					
• Overall	10323.56	16565.22	0	129940	N = 230 n = 23 T = 10
• Between		13687.05	183.469	61099.61	
• Within		9717.694	-44065.39	79163.95	
7. Population (No.)					
• Overall	2916270	2018893	298120	1.09E+07	N = 230 n = 23 T = 10
• Between		2051532	332891.9	9643376	
• Within		180431.5	1784122	4133150	

Table 72. Growth rates of import and export of different cereal crops, 1990-2009

Crops	Bangladesh		India		Pakistan	
	Import	Export	Import	Export	Import	Export
Rice						
1990-1994	-33.0 ^{ns}	--	-26.8 ^{ns}	12.5 ^{**}	184.0 [*]	4.1 ^{ns}
1995-1999	16.8 ^{ns}	26.0 ^{ns}	21.0 [*]	-12.2 ^{ns}	56.0 ^{ns}	1.4 ^{ns}
2000-2004	36.8 ^{ns}	-28.0 ^{ns}	-83.0 ^{ns}	27.0 [*]	-20.4 ^{ns}	-4.9 ^{ns}
2005-2009	-61 ^{ns}	-3.9 ^{ns}	-33.0 ^{***}	-19.0 ^{ns}	24.6 [*]	-3.7 ^{ns}
Over all	11.6 [*]	50.0 ^{***}	-32.0 ^{***}	9.7 ^{***}	15.8 [*]	4.5 ^{***}
Wheat						
1990-1994	-14.0 ^{ns}	--	-91.5 ^{ns}	-55.0 ^{ns}	9.4 ^{ns}	--
1995-1999	11.4 ^{ns}	--	111.0 ^{ns}	-189.0 ^{***}	6.0 ^{ns}	64.0 ^{ns}
2000-2004	2.7 ^{ns}	--	70.0 [*]	16.1 ^{ns}	-45.0 [*]	45.0 ^{ns}
2005-2009	8.2 ^{ns}	--	-56.8 ^{ns}	-75.0 ^{ns}	22.5 ^{ns}	-43.0 [*]
Over all	4.7 ^{***}	--	15.1 ^{ns}	2.9 ^{ns}	-8.1 [*]	79.4 ^{***}
Maize						
1990-1994	4.7 ^{ns}	--	--	189.0 ^{ns}	21.0 ^{ns}	--
1995-1999	46.0 ^{ns}	--	226.0 ^{ns}	-45.0 ^{ns}	36.8 ^{ns}	--
2000-2004	1.8 ^{ns}	--	-81.6 ^{ns}	85.0 ^{**}	-8.5 ^{ns}	--
2005-2009	25.6 ^{ns}	--	62.0 ^{***}	53.6 ^{**}	39.5 ^{ns}	--
Over all	49.8 ^{***}	--	62.3 ^{***}	53.6 ^{***}	22.3 ^{***}	--

Note: '***', '**' and '*' indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

Table 73. Growth rates of import and export of selected fruits, 1990-2009

Crops	Bangladesh		India		Pakistan	
	Import	Export	Import	Export	Import	Export
Pineapple						
1990-1994	--	--	--	-11.8 ^{ns}	14 ^{ns}	--
1995-1999	--	--	--	3.9 ^{ns}	-35.5 ^{ns}	--
2000-2004	--	--	--	22.5 [*]	78.0 ^{***}	--
2005-2009	--	--	--	-11.4 ^{ns}	-16.7 ^{ns}	--
Over all	--	--	--	23 ^{***}	10.0 ^{ns}	--
Banana						
1990-1994	--	--	--	29.0 ^{ns}	--	31.9 ^{ns}
1995-1999	--	--	--	58.5 ^{ns}	--	-71.9 ^{ns}
2000-2004	--	--	--	10.5 ^{**}	--	52.5 [*]
2005-2009	--	--	--	36.3 ^{**}	--	94.2 ^{**}
Over all	--	--	--	23.1 ^{***}	--	15.0 ^{***}

Note: '***', '**' and '*' indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

Table 74. Growth rates of import and export of pulses, oilseeds and spices, 1990-2009

Crops	Bangladesh		India		Pakistan	
	Import	Export	Import	Export	Import	Export
Pulses						
1990-1994	-14.2 ^{ns}	--	-2.1 ^{ns}	29***	30.2*	-53.8 ^{ns}
1995-1999	60.0***	--	-13.4 ^{ns}	29.4**	-80 ^{ns}	49.2***
2000-2004	16.6 ^{ns}	--	26.9 ^{ns}	0.7 ^{ns}	-6.4 ^{ns}	36.0*
2005-2009	16.5 ^{ns}	--	14.3**	-36.0***	-2.7 ^{ns}	-101.0**
Over all	12.2***	--	11.0***	11.7***	7.5***	19.0***
Oilseeds						
1990-1994	30.0**	-97 ^{ns}	9.8 ^{ns}	9.6 ^{ns}	29.5***	-1.9 ^{ns}
1995-1999	11.8 ^{ns}	78.0 ^{ns}	8.5 ^{ns}	1.1 ^{ns}	-16.3 ^{ns}	-13.1 ^{ns}
2000-2004	-10.5 ^{ns}	-1.6 ^{ns}	46.3**	0.7 ^{ns}	6.3 ^{ns}	17.9 ^{ns}
2005-2009	0.1 ^{ns}	34.5 ^{ns}	9.7 ^{ns}	9.4*	-5.1 ^{ns}	1.2 ^{ns}
Over all	5.7***	20.0*	11.9***	11.1***	18.7***	4.2**
Spices						
1990-1994	12.1 ^{ns}	-29.1 ^{ns}	92.9*	13.7***	20.3 ^{ns}	12.8**
1995-1999	60.8 ^{ns}	-24.8 ^{ns}	10.5 ^{ns}	7.4 ^{ns}	56.8 ^{ns}	4.4 ^{ns}
2000-2004	-44 ^{ns}	32.8*	45**	-2.9 ^{ns}	1.5 ^{ns}	3.6 ^{ns}
2005-2009	25.7*	-17.9 ^{ns}	4.3 ^{ns}	9.7***	84.2*	5.1 ^{ns}
Over all	8.6 ^{ns}	25.0***	42.4***	8.1***	2.5 ^{ns}	4.4***

Note: '***', '**' and '*' indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

Table 75. Growth rates of import and export of vegetable, 1990-2009

Crops	Bangladesh		India		Pakistan	
	Import	Export	Import	Export	Import	Export
Vegetables						
1990-1994	29.9 ^{ns}	23.6 ^{ns}	-10.6 ^{ns}	5.6 ^{ns}	20 ^{ns}	-8.6 ^{ns}
1995-1999	48.1 ^{ns}	9.7 ^{ns}	-9.2 ^{ns}	7.9 ^{ns}	7.4 ^{ns}	-20.8 ^{ns}
2000-2004	68.7**	0.6 ^{ns}	47.2*	9.2**	-4.7 ^{ns}	30.9 ^{ns}
2005-2009	-47.9**	-40.5**	24**	12.6***	18.3**	-12.6 ^{ns}
Over all	10.3**	12.8***	14.1***	15.6***	7.1***	21.7***
Potato						
1990-1994	-10.4 ^{ns}	--	31.2***	51.3***	32.6 ^{ns}	-28.3 ^{ns}
1995-1999	-29.0*	--	-82.5 ^{ns}	-10.6 ^{ns}	42.3 ^{ns}	99.6 ^{ns}
2000-2004	37.5*	32.9***	53.8 ^{ns}	37.9 ^{ns}	-18.7*	-5.4 ^{ns}
2005-2009	41.2 ^{ns}	-32.0 ^{ns}	-150.0 ^{ns}	11.8 ^{ns}	56.9**	77.5**
Over all	14.1***	27.8***	16.1*	17.5***	17.2***	21.4***

Note: '***', '**' and '*' indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

Table 76. Growth rates of import and export of different livestock, 1990-2009

Livestock	Bangladesh		India		Pakistan	
	Import	Export	Import	Export	Import	Export
Chicken						
1990-1994	-2.1 ^{ns}	--	--	-0.3 ^{ns}	-13 ^{ns}	-53.7 ^{ns}
1995-1999	-29.9 ^{ns}	--	--	-3.3 ^{ns}	-22.3 ^{**}	123.0 [*]
2000-2004	15.5 ^{***}	--	--	6.9 ^{ns}	-1.2 ^{ns}	26.6 ^{**}
2005-2009	43.3 ^{ns}	--	--	-72.8 ^{ns}	9.9 ^{ns}	-101.0 ^{**}
Over all	14.8 [*]	--	--	-10.4 [*]	-5.9 ^{***}	8.4 ^{ns}
Cattle						
1990-1994	--	--	65.6 ^{ns}	17.8 ^{**}	--	1.9 ^{ns}
1995-1999	--	--	-84.0 ^{**}	--	--	--
2000-2004	--	--	26.0 ^{**}	-38.7 ^{ns}	--	6.8 ^{ns}
2005-2009	--	--	--	-13.1 ^{ns}	--	101.0 ^{ns}
Over all	--	--	-18.1 ^{**}	-32.2 ^{***}	--	-12.4 ^{ns}
Goat						
1990-1994	--	--	-27.0 ^{**}	-38.0 ^{ns}	--	-10.3 ^{ns}
1995-1999	--	--	-12.1 ^{**}	-56.0 ^{ns}	--	49.3 ^{ns}
2000-2004	--	--	-7.3 ^{ns}	261.0 ^{ns}	--	8.9 ^{ns}
2005-2009	--	--	--	22.4 ^{ns}	--	15.4 ^{ns}
Over all	--	--	-13.3 ^{***}	32.3 ^{***}	--	-8.4 ^{ns}

Note: '***', '**' and '*' indicate significant at 1%, 5% and 10% level respectively, ns = Not significant

Table 77. Non-cereal agricultural commodity trade balance (value in '000'\$)

Year	Import	Export	Trade balance
1990	1923211	174283	1748928
1991	1725549	205300	1520249
1992	1864242	163785	1700457
1993	2272208	155769	2116439
1994	2244460	178145	2066315
1995	1582896	142216	1440680
1996	1794846	127130	1667716
1997	2368034	137561	2230473
1998	1988998	128802	1860196
1999	1239645	131164	1108481
2000	2025867	107786	1918081
2001	1522006	137951	1384055
2002	1459853	113756	1346097
2003	1234931	108882	1126049
2004	1448426	148097	1300329
2005	2068288	183208	1885080
2006	2149143	157558	1991585
2007	2062466	140589	1921877
2008	2015662	181840	1833822
2009	2416671	241616	2175055

Source: FAO Stat

Table 78. Non-cereal food trade balance (Value in '000'\$)

Year	Import	Export	Trade balance
1990	410844	15140	395704
1991	319889	8230	311659
1992	433698	8417	425281
1993	370034	6118	363916
1994	337013	10932	326081
1995	477430	10451	466979
1996	548667	7091	541576
1997	797260	7851	789409
1998	572042	15314	556728
1999	759391	8144	751247
2000	963038	12139	950899
2001	880400	14054	866346
2002	811550	15589	795961
2003	940226	13415	926811
2004	1159521	22993	1136528
2005	1201754	56372	1145382
2006	1257178	54344	1202834
2007	1640906	78164	1562742
2008	1802513	32602	1769911
2009	2567290	35186	2532104

Source: FAO Stat

Table 79. Percent responses on the problems and constraints of diversified crop cultivation by study areas

Type of problems	STUDY DISTRICTS												All district
	Bogra	Chittagong	Dinajpur	Faridpur	Gazipur	Jessore	Kustia	Mymensingh	Pabna	Rangamati	Rangpur	Tangail	
<i>Sample size (N)</i>	30	30	120	60	30	90	60	30	30	30	60	30	600
A. Production problem													
1. Lack of HYV seeds	26.7	30.0	15.8	13.3	--	17.8	11.7	6.7	10.0	10.0	46.7	6.7	17.5
2. Infestation of insect and diseases/crop damage in early stage	50.0	86.7	19.2	30.0	20.0	55.6	75.0	40.0	56.6	80.0	10	46.7	42.7
3. Higher cost of production	20.0	16.7	6.7	11.7	50.0	5.6	3.3	30.0	23.3	13.3	8.3	20.0	13.2
4. Lack of working capital	20.0	13.3	17.5	23.3	13.3	16.7	35.0	56.7	13.3	80.0	20.0	30.0	25.2
5. Lack of credit	--	10.0	1.7	1.7	--	8.9	--	--	--	--	--	--	2.3
6. Natural calamities	13.3	--	5.0	5.0	--	2.2	8.3	3.3	--	6.7	16.7	10.0	6.0
7. Low yield	3.3	--	1.7	1.7	3.3	--	--	--	6.7	--	--	3.3	1.3
8. Non-suitability of land	--	--	0.8	6.7	3.3	2.2	--	--	6.7	--	--	--	1.7
9. Higher cost of ploughing	--	--	4.2	6.7	--	--	--	--	10.0	--	1.7	--	2.2
10. Low quality feed	--	33.3	--	--	43.3	2.2	--	23.3	--	--	--	--	5.3
11. Lack of drainage	--	--	7.5	--	--	8.9	--	6.7	--	--	10.0	3.3	4.3
12. Pond needs frequent cleaning	--	--	--	--	--	2.2	--	16.7	--	--	--	--	1.2
B. Marketing Problems													
1. Higher price of fertilizers	60.0	--	34.2	18.3	6.7	15.6	10.0	10.0	33.3	40.0	65.0	50.0	28.5
2. Adulteration of fertilizers	20.0	--	8.3	10.0	--	4.4	--	--	16.7	10.0	--	16.7	6.5
3. Higher price of pesticides	13.3	--	8.3	--	--	14.4	20.0	--	6.7	3.3	25.0	13.3	10.2
4. Higher price of oil and fuel	--	--	10.0	8.3	--	2.2	--	--	--	--	--	10.0	3.7
5. Higher price of irrigation	--	--	11.7	3.3	--	3.3	--	--	3.3	3.3	10.0	3.3	4.7
6. Higher price of other inputs (seed, feed, etc)	--	100.0	6.7	--	83.3	25.6	--	53.3	--	--	1.7	6.7	17.5
7. Transportation problem	6.7	16.7	1.7	1.7	13.3	4.4	3.3	30.0	3.3	30.0	1.7	13.3	7.3
8. Lack of storage	3.3	--	2.5	0.0	--	0.0	--	--	--	3.3	1.7	6.7	1.3
9. Low price of outputs	43.3	16.6	11.6	20.0	49.0	--	1.7	23.4	--	13.3	21.7	26.7	15.3
10. Higher price of vitamins and vaccine	--	30.0	--	--	53.3	--	--	--	--	--	--	--	4.2

Table 79. Continued

Type of problems	STUDY DISTRICTS												All district
	Bogra	Chittagong	Dinajpur	Faridpur	Gazipur	Jessore	Kustia	Mymensingh	Pabna	Rangamati	Rangpur	Tangail	
C. Social Problems													
1. Scarcity of labour	33.3	20.0	31.7	45.0	16.7	18.9	10.0	23.3	43.3	20.0	28.3	80.0	29.3
2. Lack of training	--	6.7	4.2	3.3	--	--	5.0	6.7	--	3.3	1.7	6.7	3.0
3. Unrest in the hill and fruits stealing	--	--	--	--	--	--	--	--	--	30.0	--	--	1.5
4. Load shading of electricity	--	6.7	--	--	30.0	--	--	--	--	--	--	--	1.8
D. Other problems*	--	3.3	1.7	3.3	3.3	1.1	3.3	3.3	--	16.7	1.7	6.7	3.0

*weed infestation, inefficient irrigation system, lack of juice factory, lack of plain land, sale problem, low quality chick, pond's side erosion, lack of soil test facility, lack of govt. assistance

Table 80. Percent responses on the reasons for not growing diversified crops in the study areas

Type of reasons	STUDY DISTRICT												All district
	Bogra	Chittagong	Dinajpur	Faridpur	Gazipur	Jessore	Kustia	Mymensingh	Pabna	Rangamati	Rangpur	Tangail	
<i>Sample no</i>	<i>30</i>	<i>30</i>	<i>30</i>	<i>30</i>	<i>30</i>	<i>30</i>	<i>30</i>	<i>30</i>	<i>30</i>	<i>30</i>	<i>30</i>	<i>30</i>	<i>360</i>
1. Lack of suitable land/far away	40.0	43.3	66.7	23.3	20.0	46.7	36.7	70.0	73.3	33.3	40.0	50.0	45.3
2. Lack of own and sufficient capital	20.0	83.3	30.0	43.3	73.3	20.0	26.7	56.7	40.0	60.0	33.3	43.3	44.2
3. Scarcity of labour and its higher price	20.0	20.0	20.0	50.0	--	20.0	23.3	20.0	36.7	30.0	20.0	56.7	26.4
4. Higher production cost	33.3	16.7	16.7	26.7	16.7	10.0	6.7	10.0	56.7	43.3	30.0	30.0	24.7
5. Lack of fair price of the produces	50.0	--	16.7	40.0	16.7	10.0	3.3	6.7	6.7	6.7	40.0	13.3	17.5
6. Lack of training facility	3.3	26.7	3.3	--	13.3	10.0	3.3	30.0	6.7	6.7	6.7	--	9.2
7. Insect and disease infestation	6.7	6.7	3.3	--	13.3	20.0	36.7	--	10.0	6.7	3.3	--	8.9
8. Fertilizer price very high	10.0	3.3	6.7	16.7	--	10.0	6.7	--	10.0	13.3	13.3	10.0	8.3
9. Required higher labour	3.3	--	6.7	--	20.0	3.3	13.3	--	20.0	20.0	6.7	3.3	8.1
10. Lack of HYV seed/seedlings/check	--	--	10.0	13.3	--	13.3	--	--	--	--	30.0	10.0	7.2
11. Required long time/long duration crop	3.3	--	--	--	--	--	10.0	3.3	--	3.3	20.0	6.7	3.9
12. High risk (Bird flue, etc)	--	13.3	--	--	33.3	--	--	--	--	--	--	--	3.9
13. Lack of irrigation facility	--	--	6.7	3.3	3.3	--	--	3.3	10.0	3.3	6.7	3.3	3.3
14. Higher price of seed/seedling/feed/cheek	3.3	--	3.3	3.3	16.7	--	--	--	--	--	--	10.0	3.1
15. Natural calamities	3.3	--	--	3.3	--	3.3	--	--	3.3	--	6.7	--	1.7
16. Lack of credit	--	13.3	--	--	--	--	--	--	--	--	--	--	1.4
17. Lack of transport facility	--	3.3	3.3	--	3.3	--	--	--	--	6.7	--	--	1.4
18. Load shading of electricity	--	6.7	--	--	6.7	--	--	--	--	--	--	--	1.1
19. Other reasons*	6.7	3.3	3.3	3.3	3.3	3.3	3.3	--	3.3	6.7	3.3	6.7	3.9

* Low yield, lack of juice factory, lack of storage facility, low quality medicine, fertilizer adulteration, lack drainage, other crop cultivation

Table 81. Percent responses on the facility demanded by the non-diversified farmers for accelerating agricultural diversification

Type of facility demanded	STUDY DISTRICT												All district
	Bogra	Chittagong	Dinajpur	Faridpur	Gazipur	Jessore	Kustia	Mymensingh	Pabna	Rangamati	Rangpur	Tangail	
<i>Sample no</i>	30	30	30	30	30	30	30	30	30	30	30	30	360
1. Required suitable land	40.0	33.3	46.7	--	10.0	36.7	30.0	60.0	46.7	30.0	26.7	16.7	31.4
2. Required financial assistance (i.e. subsidy)	16.7	36.7	13.3	30.0	43.3	3.3	36.7	30.0	40.0	56.7	16.7	23.3	28.9
3. Agril. credit with low interest rate	20.0	43.3	10.0	26.7	50.0	40.0	6.7	26.7	--	26.7	43.3	33.3	27.2
4. Availability and Lower prices of inputs	20.0	--	13.3	40.0	13.3	20.0	20.0	10.0	6.7	13.3	40.0	23.3	18.3
5. HYV seed timely/short duration crop/availability	33.3	16.7	20.0	20.0	3.3	20.0	26.7	23.3	20.0	--	43.3	3.3	19.2
6. Ensure fair price of the produces	46.7	6.7	16.7	36.7	13.3	16.7	10.0	--	13.3	16.7	30.0	10.0	18.1
7. Provide hand-on training	3.3	30.0	6.7	6.7	16.7	16.7	3.3	20.0	3.3	10.0	10.0	6.7	11.1
8. Availability of labour	3.3	--	10.0	16.7	--	--	--	3.3	23.3	13.3	10.0	26.7	8.9
9. Lower price of fuel/oil	--	3.3	--	26.7	--	--	--	3.3	10.0	--	3.3	3.3	4.2
10. Irrigation facility	--	--	10.0	3.3	--	--	--	--	--	10.0	10.0	--	2.8
11. Develop better transportation system	--	3.3	--	--	3.3	--	--	--	--	3.3	--	--	0.8
12. Ensure continuous electricity supply	--	3.3	--	--	13.3	--	--	--	--	--	--	--	1.4
13. Others facility needed*	--	--	3.3	--	3.3	--	--	--	3.3	3.3	6.7	6.7	2.2

* Reduce middlemen, drainage facility, vaccination, juice factory, storage facility

End Note

Methods of Crop Diversification Measurement

There are several methods, which explain diversification of crops in a given time and space by single indicator. Important methods among others are: (i) Herfindahl Index (HI), (ii) Transformed Herfindahl Index (THI), (iii) Ogive Index (OI), (iv) Entropy Index (EI), (v) Modified Entropy Index (MEI), and (vi) Composite Entropy Index (Islam and Rahman, 2012). The brief description of the first five indices is given below:

Herfindahl Index (HI): The mathematical formula of HI is given by:

$$HI = \sum_{i=1}^N P_i^2$$

Where, N = Total number of crops, and

P_i = Proportion of acreage of the i^{th} crop to total cropped area.

The value of HI is bounded by zero and one. The value of HI tends to zero as N becomes larger, while it tends to one when only one crop is cultivated. (i.e. $N = 1$ and $P_i = 1$). Increasing value HI indicates increase in diversification.

Transformed Herfindahl Index (THI): The transformed Herfindahl index is defined by:

$$THI = (1 - HI)$$

Its value increases with the increase in diversification and assumes zero value in case of perfect concentration (i.e. $N = 1$ and $P_i = 1$). Increasing value THI indicates increase in diversification.

Ogive Index (OI): Ogive index was first used by Tress in 1938 to measure the industrial diversity. It is defined as:

$$OI = \frac{\sum_{i=1}^N \left\{ p_i - \frac{1}{N} \right\}}{\frac{1}{N}}$$

Like HI, OI is also subtracted from unity to have the level of diversity and to make it comparable to other indices. But the main limitation of OI is that it takes zero value at the two extreme cases, i.e. both for perfect specialization and perfect diversification. Increasing value OI indicates increase in diversification.

Entropy Index (EI): The mathematical formula of EI is given below:

$$EI = -\sum p_i \log p_i$$

The value of the index varies from 0 to $\log N$. When there is perfect specialization, EI takes the value zero and when there is perfect diversification, it takes the value $\log N$. The value of EI depends on the base of logarithm and the number of crops (De, U. K. 2000). Increasing value EI indicates increase in diversification.

Modified Entropy Index (MEI): The mathematical formula of MEI is given below:

$$MEI = \sum_{i=1}^N p_i \log_N p_i$$

The value of this index varies from zero to one. It takes the value zero when there is a perfect concentration, while it takes the value one when there is a perfect diversification. Increasing value MEI indicates increase in diversification.