BANGLADESH JOURNAL OF POLITICAL ECONOMY

VOLUME 29 NUMBER 1

JUNE 2013

(See Back Page)

বাংলাদেশ অর্থনীতি সমিতি
Bangladesh Economic Association

Bangladesh Journal of Political Economy

VOLUME 29, NUMBER 1, JUNE 2013

Abul Barkat
Editor

Bangladesh Economic Association

4/C, Eskaton Garden Road, Dhaka-1000
Phone : 9345996, Fax : 880-2-9345996
Website : bea-bd.org
E-mail : bea.dhaka@gmail.com

বাংলাদেশ জার্নাল অফ পলিটিক্যাল ইকনমি

উনত্রিংশ খ-, সংখ্যা ১, জুন ২০১৩

বাংলাদেশ অর্থনীতি সমিতি

৪/সি, ইস্কাটন গার্ডেন রোড, ঢাকা-১০০০

টেলিফোন ঃ ৯৩৪৫৯৯৬, ফ্যাক্স : ৮৮০-২-৯৩৪৫৯৯৬

ওয়েব সাইট : bea-bd.org

ই-মেইল : bea.dhaka@gmail.com

Bangladesh Journal of Political Economy

VOLUME 29, NUMBER 1, JUNE 2013

Bangladesh Economic Association

- Bangladesh Journal of Political Economy is published by the Bangladesh Economic Association.
- No responsibility for the views expressed by the authors of articles published in the Bangladesh Journal of Political Economy is assumed by the Editors or the Publisher.
- Bangladesh Economic Association gratefully acknowledges the financial assistance provided by the Goverment of the People's Republic of Bangladesh towards publication of this volume.
- The price of this volume is Tk. 200, US $ 15 (foreign). Subscription may be sent to the Bangladesh Journal of Political Economy, c/o, Bangladesh Economic Association, 4/C, Eskaton Garden Road, Dhaka-1000. Telephone: 9345996. Website : bea-bd.org E-mail : bea.dhaka@gmail.com Members and students certified by their concerned respective institutions (college, university departments) may obtain the Journal at 50% discount.

Cover design by:
Syed Asrarul Haque (Shopen)

Printed by:
Agami Printing & Publishing Co.
27 Babupura, Nilkhet,
Dhaka-1205, Phone: 01971 118 243

BEA Executive Committee 2012-2014

Editor's Note

This volume (Vol. 29, No. 1) of Bangladesh Journal of Political Economy (BJPE) contains select papers presented at the Bangladesh Economic Association (BEA) 18th Biennial Conference held in 2012 and papers presented at the Regional Conferences organized by BEA during 2012-14 period in Chittagong, Kushtia, Mymensingh, and Rajshahi. In addition to these, this volume contains articles which are submitted to the Editor for publication mostly during the last one year. All the papers included in this volume were reviewed by both internal and external reviewers, and concurred by the Editorial Board for publication.

Let me express my indebtedness to the authors, the reviewers, and the members of the Editorial Board of the Journal. Special thanks are due to Prof. Ayubur Rahman Bhuyan and Prof. Toufic Ahmad Choudhury, who, as members of the Editorial board of the Journal, shouldered much more responsibilities than usual for a member.

(Abul Barkat)
Editor, Bangladesh Journal of Political Economy
President, Bangladesh Economic Association

বাংলাদেশ অর্থনীতি সমিতির ষান্মাসিক জার্নাল Bangladesh Journal of Political Economy *প্রকাশনার নীতিমালা*

১। অর্থনীতির বিভিন্ন শাখায় তাত্ত্বিক এবং প্রায়োগিক বিষয়ে প্রবন্ধ প্রণয়ন করার জন্য প্রবন্ধকারদেরকে অনুরোধ জানানো হবে। ইংরেজী এবং বাংলা উভয় ভাষায় রচিত প্রবন্ধ জার্নালের জন্য গ্রহণ করা হবে।

২। Initial screening নির্বাহী সম্পাদকের এখতিয়ারভুক্ত থাকবে, তবে প্রয়োজনবোধে সম্পাদনা পরিষদের অন্য সদস্যদের সহায়তা তিনি নেবেন। নির্ধারিত format মোতাবেক সংশোধনের জন্য এই পর্যায়ে প্রাথমিক ভাবে short-listed প্রবন্ধসমূহ প্রবন্ধকারের কাছে প্রেরণ করা হবে।

৩। অভ্যন্তরীণ reviewer সাধারণতঃ সম্পাদনা পরিষদের সদস্যদের মধ্য থেকেই মনোনীত হবেন। বহিঃস্থ reviewer সম্পাদনা পরিষদের সিদ্ধান্তক্রমে প্রবন্ধের বিষয়ের ভিত্তিতে সম্পাদনা পরিষদের বাইরে থেকে মনোনীত হবেন, তবে তিনি দেশের অভ্যন্তরে বা বিদেশে অবস্থান করতে পারেন। সম্পাদনা উপদেষ্টা কমিটির সকল সদস্য reviewer হতে পারবেন। তৃতীয় reviewer প্রয়োজন হলে সম্পাদনা পরিষদের বাইরে থেকে মনোনীত করা হবে।

৪। ক) সমিতির দ্বিবার্ষিক কনফারেন্সে উপস্থাপিত প্রবন্ধগুলো referral প্রক্রিয়ার মাধ্যমে জার্নালের জন্য বিবেচিত হবে।

খ) বিভিন্ন সময়ে সমিতি কর্তৃক আয়োজিত সেমিনারে পঠিত আমন্ত্রিত প্রবন্ধসমূহ জার্নালের সম্পাদনা পরিষদের অনুমোদনক্রমে জার্নালে প্রকাশ করা যেতে পারে।

৫। অর্থনীতি সমিতির সদস্য এবং সদস্য-বহির্ভূত যে কোন আগ্রহী প্রার্থী জার্নালের গ্রাহক হতে পারবেন। তবে সদস্যদের ক্ষেত্রে গ্রাহক ফি (subscription fee) পঞ্চাশ শতাংশ রেয়াত দেয়া হবে।

৬। জার্নালের footnoting এবং writing style এতদ্‌সঙ্গে সংযোজিত হলো (জার্নালের শেষাংশ)।

৭। দেশের অভ্যন্তরে অবস্থানকারী উপদেষ্টা কমিটির সদস্যদেরকে বছরে দু'বার সম্পাদনা পরিষদের সভায় আমন্ত্রণ জানানো হবে।

৮। ক) তিনটি কোটেশন সংগ্রহ করে সম্পাদনা পরিষদের সিদ্ধান্তক্রমে মুদ্রক প্রতিষ্ঠান নির্বাচন করা হবে।

খ) প্রথম proof প্রেস দেখবে, পরবর্তীতে softcopy তে প্রবন্ধকার ফাইনাল proof দেখে দেবেন।

Bangladesh Journal of Political Economy
VOLUME 29, NUMBER 1, JUNE 2013

Contents

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 001-007
Bangladesh Economic Association
(ISSN 2227-3182)

A Note on the Impact of Microcredit on Farm Income in Bangladesh : A Propensity Score Matching Approach

MD. ABDUL WADUD*

Abstract *Propensity score matching (PSM) refers to the pairing of treatment and control units with similar values on the propensity score. Applying the PSM to a sample of 682 farms of which 450 are microcredit receivers and the rest 232 are microcredit non-receivers, the impact of microcredit on farm income is assessed. Results show a positive impact of microcredit on farm income indicating that the average income of microcredit receiving farms is 9.46 per cent higher than that of microcredit non-receiving farms. Thus this research can have strong bearing on policymaking and implementation in agriculture of developing economies like Bangladesh.*

Keywords: *Propensity Matching Score; Microcredit; Farm Income; Bangladesh*

JEL Codes: *Q1-Agriculture; C13 - Estimation*

1. Introduction

Microcredit is assumed likely to contribute both directly and indirectly to agricultural farm income. Agriculture in Bangladesh is characterized by a large number of small and marginal farms with limited financial resources and hence farmers can not apply optimal inputs and new production technologies for higher production. This results in lower production and farm income, and timely and proper application of inputs like fertilizer, pesticides and irrigation is important for higher production. Therefore, cash for the purchase of seeds, chemical fertilizers, pesticides and mechanical equipments is of utmost importance.

* Professor, Department of Economics, Rajshahi University, Rajshahi 6205, Bangladesh

Farmers in the rural areas require financial support from institutional and non-institutional sources to meet the expenses of various agricultural activities. With very low level of income it is difficult for them to accumulate capital for meeting the production expenditure. As such, a large number of farmers in rural Bangladesh are dependent on credit.

As marginal and small farmers have little or no access to formal sources of credit, microcredit can provide them access to inputs like seed, fertilizer and irrigation at proper time. This, in turn, helps use of new production technologies, thereby increasing food production and farm income.

Recently, the government of Bangladesh, Palli Karma-Sahayak Foundation (PKSF) and other institutions have started funding in agricultural activities. Use of microcredit in agriculture has been on the increase and now it constitutes about 40 percent of all credits that the farmers receive. *A priori,* it is thought that microcredit could have a positive impact in enhancing efficiency performance of farms, and hence raise farm income of marginal and small farmers. It has, therefore, become necessary to study the impact of microcredit on farm income. The present research is designed to achieve this objective. To the best of my knowledge, this research is first of its kind in Bangladesh.

The rest of the paper is organized as follows. Section 2 describes the empirical framework and data; Section 3 gives results and Section 4 provides conclusion of the study.

2. Empirical Framework and Data

2.1. Empirical Framework: Propensity Score Matching (PSM) Technique

Propensity score matching (PSM) refers to the pairing of treatment and control units with similar values on the propensity score. Matching has become a popular approach to estimate causal treatment effects. It is widely applied when evaluating labour market policies (Heckman *et. al.*, 1997 and 1998; Dehejia and Wahba, 1999), but empirical examples can be found in very diverse fields of study. It applies for all situations where one has a treatment, a group of treated individuals and a group of untreated individuals. The nature of treatment may be very diverse. For example, Perkins *et. al.* (2000) discuss the usage of matching in pharmacoepidemiologic research. Hitt and Frei (2002) analyse the effect of online banking on the profitability of customers. Davies and Kim (2003) compare the effect on the percentage bid–ask spread of Canadian firms being interlisted on a US Exchange, whereas Brand and Halaby (2006) analyse the effect of elite college attendance on career outcomes. Ham *et. al.* (2004) study the effect of a migration decision on the wage growth of young men. Bryson et.al. (2002) analyse the effect of union membership on wages of employees.

Matching is a widely-used non-experimental method of evaluation that can be used to estimate the average effect of a particular program.[3] This method compares the outcomes of program participants with those of matched non-participants, where matches are chosen on the basis of similarity in observed characteristics. Suppose there are two groups of farmers indexed by participation status $P = 0/1$, where 1 (0) indicates farms that did (not) participate in a program. Denote by the outcome (performance of farm) conditional on participation (P = 1) and by the outcome conditional on non-participation (P = 0).

The most common evaluation parameter of interest is the mean impact of treatment on the treated, $ATT=E(Y_1\text{-}Y_0\backslash p=1)=E[Y_1\backslash p=1)]\text{-}EY_0\backslash p=1]$, which answers the following question: 'How much did farms participating in the program benefit compared to what they would have experienced without participating in the program?' Data on $E[Y_1\backslash p=1)]$ are available from the program participants. An evaluator's 'classic problem' is to find, $E[Y_0\backslash p=1)]$ since data on non-participants enables one to identify $E[Y_0\backslash p=1)]$ only. So the difference between and $E[Y_1\backslash p=1)]$ and $E[Y_0\backslash p=1]$ cannot be observed for the same farm.

The solution advanced by Rubin (1979) is based on the assumption that given a set of observable covariates ***X***, potential (non-treatment) outcomes are independent of the participation status (conditional independence assumption-CIA):Y_0 $S\backslash X$. Hence, after adjusting for observable differences, the mean of the potential outcome is the same for P = 1 and P = 0, $E[(Y_0\backslash p=1)=E[Y_0\backslash p=0,x)]\text{-}EY_0\backslash p=1]$. This permits the use of matched non-participating farms to measure how the group of participating farms would have performed, had they not participated.

We conducted a survey on 682 farms of which 450 are microcredit receivers and the rest 232 are microcredit non-receivers using a structured questionnaire in 2009. The questionnaire included questions about household characteristics such as microcredit, experience, education, land fragmentation and land size of farm households.

3 A detailed discussion of the matching approach as well as a survey on its applications in labour-market evaluation studies is available in Heckman, LaLonde and Smith (1999), Caliendo (2006) as well as Caliendo and Kopeinig (2007).

3. Results from Logistic Regression and Propensity Scores

Propensity score matching (PSM) technique is used to assess the impact of microcredit. We apply the specification of logistic regression model to obtain propensity score as a function of set of variables of experience and years of schooling of farms, and land fragmentation and farm size of farms. The estimated propensity score abstracts the information of the covariates of participants as x and participant's status on the variable as y. Using the estimated propensity score, we match a participant from the treatment group (microcredit receivers) with a participant from the control group (microcredit non-receivers) to facilitate causal inference so that the treatment group and control group are balanced. This approach significantly reduces the selection bias in observational study (Rosenbaum, 1987 and 2004; Rosenbaum and Rubin, 1985; and Rubin and Thomas, 1992). Ideally, the farmers representing on matched pair are identical to each other except microcredit. As a consequence, this approach isolates the impact idiosyncratic factors have on outcome variables by reducing heterogeneity between microcredit receivers and non-receivers. An important characteristic of this technique is that, after units of the groups are matched, the unmatched comparison units are discarded and not used in estimating the impact. Results are given in Table 1.

Different algorithms can be employed to identify matching pairs after the propensity score is estimated (Rubin, 1974). We used the Nearest-Neighbor Algorithm in this study as this algorithm is the most applied algorithm. This method matches each treated observation with a controlled observation with the closest propensity score.

Table 1: Logistic Regression for Propensity Score [2] and Program Effect

Regressor	Coefficient	t-ratio
Experience	.013073	3.1139
Education	.014853	.81103
Land Fragmentation	.11909	.31938
Farm Size	-.033486	-.35956
Goodness of fit		0.65982
Maximized value of the log-likelihood function		-442.7508
Program Effect		
Mean Income of Matched Treated		18397.40
Mean Income of Matched Controlled		16656.30
Impact of Microcredit Program		1741.13

Note: Total number of observations is 682; Microcredit receivers and non-receivers are 450 and 232, respectively. Matched treated and controls are 165 and 165, respectively. Factor for the calculation of marginal effects = .22943, Pseudo-R-Squared = .063410

Once each treated farmer is matched with a control farmer, the difference between the outcome of the treated farmer and the outcome of the control farmer is calculated. The average effect of treatment on the treated (ATT) is then obtained by averaging these differences. The impacts of the microcredit program for agriculture are shown at the end of Table 1. The microcredit program as a whole has a positive impact on the average income of farms. This positive impact means that those receiving microcredit earn, on an average, 9.46 per cent more than those who did not.

4. Conclusions

This study aims to assess the impact of microcredit on farm income. We apply the propensity score matching (PSM) technique to a sample of 682 farms of which 450 are microcredit receivers and the rest 232 are microcredit non-receivers. Results reveal that microcredit contributes to generation of income of farms. The average income of microcredit receiving farms is 9.46 per cent higher than that of microcredit non-receiving farms. Based on the results, we conclude that policies which extend microcredit and ensure fair, timely and low-cost delivery of microcredit to marginal and small farmers could lead to an increase in agricultural farm output and income in Bangladesh.

References

1. Brand, J.E. and Halaby, C.N., 2006, Regression and matching estimates of the effects of elite college attendance on educational and career achievement, *Social Science Research*, 35(3): 749–770.
2. Bryson, A., 2002, The union membership wage premium: an analysis using propensity score matching, Discussion Paper No. 530, Centre for Economic Performance, London.
3. Bryson, A., Dorsett, R. and Purdon, S., 2002, The use of propensity score matching in the evaluation of labour market policies. Working Paper No. 4, Department for Work and Pensions.
4. Caliendo, M. and Kopeinig, S., 2008, Some Practical Guidance for the Implementation of Propensity Score Matching, *Journal of Economic Surveys*, 22, 1, 31-72.
5. Caliendo, M., 2006, Microeconometric Evaluation of Labour Market Policies, Lecture Notes in Economics and Mathematical Systems. Springer.
6. Davies, R. and Kim, S., 2003, Matching and the estimated impact of interlisting, Discussion Paper in Finance No. 2001-11, ISMA Centre, Reading.
7. Dehejia, R. und Wahba, S., 1999, Causal effects in nonexperimental studies: reevaluation the evaluation of training programs, *Journal of the American Statistical Association*, 94, H. 448, S. 1053-1062.
8. Ham, J., Li, X. and Reagan, P., 2004, Propensity score matching, a distance-based measure of migration, and the wage growth of young men, Working Paper, Department of Economics, Ohio State University.
9. Heckman, J.J., Ichimura, H. and Todd, P.E., 1997, Matching As An Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme, *Review of Economic Studies,* 64, 605-654.
10. Heckman, J.J., Ichimura, H. and Todd, P.E., 1998, Matching as an Econometric Evaluation Estimator, *Review of Economic Studies*, 65, 261-294.
11. Heckman, J.J., LaLonde, R. J. and Smith, J., 1999, The economics and econometrics of active labor market programs, in: Ashenfelter, O. and Card, D. E. (Hrsg.): Handbook of Labor Economics. Vol. 3. Amsterdam. S. 1865-2097.
12. Hitt, L. M. and F. X. Frei, 2002, Do better customers utilize electronic distribution channels? *The case of PC banking. Management Science*, 48(6): 732-749.

13. Perkins, S.M., Tu, W., Underhill, M.G., Zhou, X. and Murray, M.D., 2000, The use of propensity scores in pharmacoepidemiologic research, *Pharmacoepidemiology and Drug Safety*, 9(2): 93–101.

14. Rosenbaum, P. R., 1987, Model-Based Direct Adjustment, *Journal of the American Statistical Association*, 82, 387–394.

15. Rosenbaum, P. R., 2004, Design Sensitivity in Observational Studies, *Biometrika*, 91 (1), 153 - 164.

16. Rosenbaum, P. R., 2005, Heterogeneity and Causality: Unit Heterogeneity and Design Sensitivity in Observational Studies, *The American Statistician*, 59: 147–152.

17. Rubin, D. B. and N. Thomas, 1992, A?nely Invariant Matching Methods with Ellipsoidal Distributions, *Annals of Statistics,* 20 (2): 1079–1093.

18. Rubin, D. B., 1974, Estimating Causal E?ects of Treatments in Randomized and Nonrandomized Studies, *Journal of Educational Psychology*, 66 (5): 688–701.

19. Rubin, D., 1979, Using multivariate matched sampling and regression adjustment to control bias in observational studies, *Journal of the American Statistical Association,* 74(366): 318–328.

20. Sianesi, B., 2001, Implementing Propensity Score Matching Estimators with STATA, UK Stata Users Group, VII Meeting London, May 2001.

Bangladesh Journal of Political Economy

Vol. 29, No. 1, June 2013, pp. 009-024
Bangladesh Economic Association
(ISSN 2227-3182)

Adoption Performance of IRRI Supported Submergence Tolerant Rice Variety in Bangladesh*

Md. Saidur Rahman**
Nahid Sattar***

Abstract *Submergence is a major problem for cultivating aman rice in many parts of Bangladesh. BRRI dhan51 is a rice variety which can withstand submergence for 10 to 14 days and still produce an yield of 4 to 4.5 tons/ha. The successful adoption of any variety may not be dependent just on its physical properties but also on its socio-economic acceptability. The objective of this study was to judge the profitability of BRRI dhan51 by comparing it with another local check variety- BR11. A total of 120 farmers were selected for having primary data from Rangpur and Mymensingh. The results observed that BRRI dhan51 cultivation was more profitable than BR11. The profitability analysis of BRRI dhan51 cultivation showed that the coefficients of human labour cost, seed cost, fertilizer cost, irrigation cost and power tiller cost were positive and significant at 5 percent level of significance at Rangpur and Mymensingh. The study revealed that resistance to submergence, high yield, good taste and less fertilizers were the main reasons for adopting BRRI dhan51. The analysis also suggested that although adoption of the variety was more concentrated to sources of seed, farmers from distant places were also interested to grow it.*

---

* This paper is based on the report of Tracking Varietal Uptake and Assessment of STVS Project funded by IRRI, Philippines and implemented through BSERT, BAU. Paper prepared for the regional seminar jointly organized by the Bangladesh Economic Association and Faculty of Agricultural Economics and Rural Sociology, BAU, Mymensingh on the theme "Changing Farming System in Bangladesh and its implication for Food Security" in 26 October 2013.

** Associate Professor, Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh.

*** Lecturer, Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh

1. Introduction

Rice is the most significant crop in Bangladesh. It is the largest crop in terms of both area of production and value of production. Rice was cultivated in 76.23 percent of total cropped area during 2007-08 and it occupied 60.70 percent of gross value addition of crops during 2007-08 (BBS 2010). Among the three seasons for rice in Bangladesh, Aman is one of the most important seasons. The area coverage of Aman is the highest as a single crop in the country with 54,80,000 hectares of land being under Aman cultivation in 2009-10 season. It is also the second largest crop in the country, after Boro, in respect of the volume of production with 11152000 metric tons of production during the same season (BRRI 2012a).

Rice is also very important from consumption point of view in Bangladesh. It is the staple food for almost the entire population of Bangladesh. Rice consumption in this country is around 168 kg/capita/year, which is one of the highest in the world, and 76 percent of the food calorie intake for the people of Bangladesh comes from rice (IRRI 2011). The poor in Bangladesh spend a large part of their income on rice. The consumption of rice will continue to increase as incomes increase with growing urbanization. Rice is often regarded as a political commodity in Bangladesh (Sarwar, 2003). So, long term growth and stability in rice production, especially Aman and Boro production, is very crucial to ensure food security for the country in the long run.

However, the Aman season in Bangladesh is subject to natural disasters like flood which hamper its production and in some years damage the standing crops. Each year in Bangladesh about 26,000 km^2, (around 18%) of the country is flooded, killing many people and destroying homes, animals, crops and other properties. Aman rice is cultivated during the monsoon season when most of the flooding occurs. Monsoon floods from the major rivers generally rise slowly and the period of rise and fall may extend from 10 to 20 days or more. So, submergence is a major threat for Aman rice production. On this background, different international agricultural research organizations have been trying to develop submergence tolerant rice varieties. During 2010, Bangladesh Rice Research Institute (BRRI) in collaboration with International Rice Research Institute (IRRI) developed two submergence-tolerant varieties BRRI Dhan51 and BRRI Dhan52. The normal yield for these varieties is 5-5.5 tonnes per hectare, but when submerged for 10-14 days, the yield is still 4-4.5 tonnes per hectare (BRRI 2012b). So, these varieties can offset the damages caused by floods to a great extent.

The success for any variety in the field may not be dependent only on its physical properties or qualities. If a new variety fails to achieve socio-economic acceptability, it may not last long among the farmers. So, studying the profitability and socioeconomic acceptability of any new rice variety is very important. It is also worthwhile to study the adoption pattern of any such new variety in order to understand the obstacles in the adoption of such varieties in the field. Keeping these in mind, this study is an effort to judge the profitability of BRRI dhan51 by comparing it with another competitive rice variety and understanding the adoption scenario of BRRI dhan51. The other rice variety can be identified as competitive from economic perspective if farmers cultivate that during the same season using similar resources, irrespective of its genetic properties. In this study, the other variety under comparison is BR11. This variety is chosen because it is the most popular rice variety which is cultivated during the Aman season in the areas under study.

A number of studies were conducted on different aspects of new varieties adoption and economic comparison (BRRI, 2012b; IRRI, 2006; Jabbar, et. al., 1993 and Sarwer, 2003). While these studies made general conclusions about the adoption process of new varietyies, these did not emphase their economic aspect to the farmers. In addition to that there were little empirical insights into the magnitude of variety adoption. In this study, emphasis is laid on the economic aspect of the new variety. The specific objectives of the study are: to identify the socioeconomic profile of BRRI dhan51 and check variety (BR11) farmers; to compare the profitability of BRRI dhan 51; to observe the adoption patterns of BRRI dhan51; to track varietal adoption scenario of BRRI dhan51 in the study area; and to make policy recommendations for future.

2. Materials and method

Farm management research requires selection of an area where the research is conducted and related information is collected. Moreover, the area in which farm business survey is to be conducted depends on the specific purpose of the survey and the possible co-operation from the respondents. Keeping these in mind one village named Dhorsana under Rangpur district and three villages named Dharsa, Uttar Dunghata and Moddo Dungata of Mymenshingh district were selected for the present study.

Aman season generally begins in August and ends in November. To satisfy the objectives of the study, data on the costs and returns of BRRI dhan51 and BR11 for the two areas were collected using survey method in October 2011. At first, lists of the farmers who produced BRRI dhan51 or BR11 in the study areas was taken. Then from those lists, 30 farmers growing BRRI dhan51 and 30 farmers of BR11 were selected randomly. So the total sample size was 120 from two districts. The final questionnaires for both locations contained three categories of information. The purpose of the first category was to obtain information about the socio-economic conditions of the selected farmers. The second category was to obtain information related to the costs and returns of the two selected rice varieties. The third category was to obtain information related to constraints and problems faced by the farmers in producing BRRI dhan51 and BR11 rice.

Analytical Techniques Used

All the collected data were checked and cross-checked before posting those to the Excel spread sheet. Thereafter the gathered data were classified, tabulated and analyzed in accordance with the objectives of the study. Tabular techniques were applied mostly to get arithmetic mean, averages, percentages and ratios. Farm business analytical techniques such as enterprises costing, gross margin analysis, etc. were performed to see the profitability of the enterprises. Finally, econometric technique such as Cobb-Douglas type revenue function was used to examine the effects of the independent variables on the dependent variables in the production of BRRI dhan51 and BR11 varieties of rice.

Econometric model specification: Cobb-Douglas Type Revenue Function

In order to estimate the effects of key variables in the BRRI dhan51 and BR11 rice production the Cobb-Douglas form of revenue function was used in the study (Gujarati, 1995). The specification of the Cobb-Douglas type revenue function for BRRI dhan51 and BR11 was as follows:

$$Y_i = aX_1 b_1 X_2 b_2 \ X_3 b_3 X_4 b_4 \ X_5 b_5 \ e u_i$$

In the Log Linear form it can be written as:

$$\text{InY=Ina} + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + U_i$$

Where,

Y = Return per hectare in taka
X_1 = Human labor cost (Tk./ha)
X_2 = Seed cost (Tk./ha)
X_3 = Fertilizer cost (Tk./ha)
X_4 = Irrigation cost (Tk./ha)

X_5 = Hiring power tiller cost (Tk./ha)
a = Constant or intercept term

b_1, b_2, b_3, b_4, b_5 = production coefficient of the respective inputs variables to be estimated and

U_i = Error term

4. Results

Socioeconomic profile of the cultivating farmers

It can been seen in Table 1 that about 17 percent of the BRRI dhan51 farmers in Rangpur and 13 percent of the BRRI dhan51 farmers in Mymensingh fell into the less than 30 years of age group. It maybe noted that more farmers (53 percent) belonging to the middle aged group (30-40 years) cultivated BRRI dhan51, as opposed to 27 percent of the same group cultivating BR11 in Rangpur. Again, proportionately more farmers (60 percent) of higher age group (41 years and above) cultivated BR11, when a lesser proportion (30 percent) of the same age group cultivated BRRI dhan51. The figures indicate that younger farmers might have adopted BRRI dhan51 more than the relatively aged farmers. However, this was not true in case of Mymensingh where, the age distribution of farmers was similar for both the varieties.

Educational status of the respondents

To examine the educational status of BRRI dhan51 and BR11 growing farmers, the educational status of the sample farmers was divided into four categories.

Table 1 : Age distribution of the respondents

Age	Rangpur				Mymensingh			
	BRRI dhan51 farmers		BR11 farmers		BRRI dhan51 farmers		BR11 farmers	
	No.	%	No.	%	No.	%	No.	%
Less than 30 years	5	17	4	13	4	13	5	17
30-40 years	16	53	8	27	10	33	9	30
41 years and above	9	30	18	60	16	53	16	53
Total	30	100	30	100	30	100	30	100

Source: *Field Survey, 2010*

These were (i) illiterate, (ii) primary level (class I-V), (iii) secondary level (class VI to X) and (iv) above secondary level of education. Those who cannot sign, read and write were considered as illiterate. It is observed from the study that in Rangpur, 23 per cent of BRRI dhan51 cultivating farmers are illiterate, 20 per cent has primary education, 50 percent has up to secondary education and 6 percent has above secondary level education. On the other hand, these percentages for BR11 growing farmers are 18, 32, 45 and 5, respectively. In the case of Mymensingh, 27 per cent of BRRI dhan51 cultivating farmers are illiterate, 40 per cent has primary education, 27 percent has up to secondary education and 7 percent has above secondary level education. On the other hand, these percentages for BR11 growing farmers are 40, 37, 20 and 3, respectively. A significant fact to note from the table is that majority of the farmers (56 percent) at Rangpur, who cultivated BRRI dhan51 had educational qualification of secondary level or above. Also, at Mymensingh the BRRI dhan51 cultivating farmers were proportionately more educated than BR11 cultivating farmers (Fig. 1). So, higher education has a better role for adopting new variety of rice particularly in those areas.

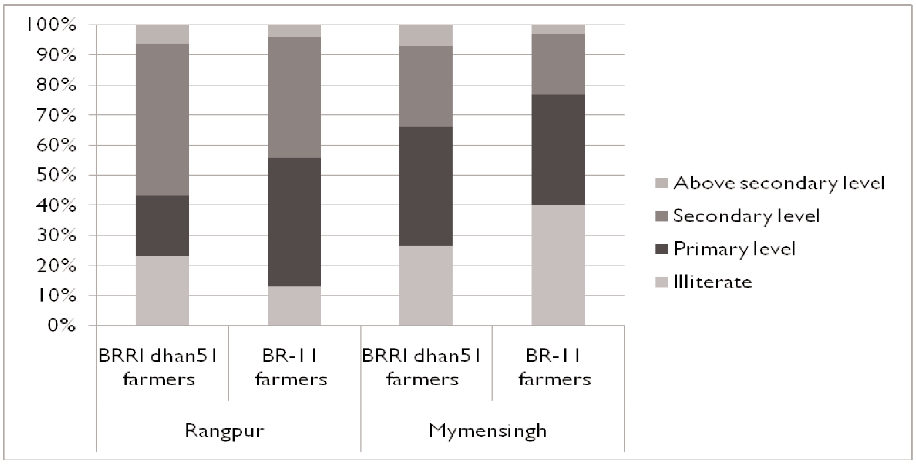


Fig. 1. Educational status of the respondents

Occupational status of sample farmers

Agriculture is the main occupation for majority of the selected farmers in this study (Table 3). Besides agriculture, some farmers are engaged in petty trading and others are employed in government, semi government or private services or teaching. At Rangpur, in the case of BRRI dhan51 growers, 84 percent farmers are engaged in agriculture, 3 per cent in business and 13 per cent in service as their main occupation. In the case of BR11 growers, 67 percent farmers are engaged in agriculture, 23 percent in business and 10 percent engaged in service as their main occupation. The percentage of cultivators with agriculture as their main occupation is more in case of BRRI dhan51 growers (84 percent) as compared to BR11 growers (67 percent). It indicates that the true farmers are adopting new variety more than others. However, the situation is different at Mymensingh. There, the percentage of cultivators with agriculture as their main occupation is higher in the case of BR11 growers (86.67 percent) as compared to BRRI dhan51 growers (76.67 percent).

Table 3 : Primary occupation of sample farmers

Occupation	Rangpur				Mymensingh			
	BRRI dhan51 farmers		BR11 farmers		BRRI dhan51 farmers		BR11 farmers	
	No.	%	No.	%	No.	%	No.	%
Agriculture	25	83.33	20	66.67	23	76.67	26	86.67
Business	1	3.33	7	23.33	3	10.00	1	3.33
Service	4	13.33	3	10.00	1	3.33	1	3.33
Teacher	0	0.00	0	0.00	2	6.67	2	6.67
Fisher	0	0.00	0	0.00	1	3.33	0	0.00
Total	30	100	30	100	30	100	30	100

Source: *Field Survey, 2010*

Average farm size of the sample farmers

According to Yang (1965) farm size refers to the entire land area operated by the operator. It is measured by adding the area of land owned and the area of land rented-in from others and subtracting the area rented to others. It takes into account both the homestead area and the area used for woods, pasture and crops. In this research, the farm size of a farmer was measured by using the following formula:

Farm size = Homestead + own cultivable land + Rented-in land + mortgaged-in land - (Rented-out land + Mortgaged-out land).

The average farm size of the sample farmers are shown in Table 4.

Table 4 : Average farm size of selected farmers

Items	Rangpur		Mymensingh	
	BRRI dhan51 farmers	BR11 farmers	BRRI dhan51 farmers	BR11 farmers
Homestead (ha)	0.03	0.04	0.10	0.08
Farm land				
Owned	0.10	0.16	1.15	0.95
Mortgaged-in	-	-	-	-
Rented-in	0.50	0.29	0.26	0.29
Mortgaged/ rented out	-	-	-	-
Farm size (ha)	0.63	0.49	1.51	1.22

Source: *Field Survey, 2010*

Table 4 presents the average land ownership pattern and tenurial arrangements of selected farmers. It can be seen from the table that the average farm size is larger for the selected farmers of Mymensingh compared to the farmers of Rangpur. The average farm size is 1.51 and 1.22 hectares for BRRI dhan51 and BR11 cultivating farmers, respectively, at Mymensingh, while the average farm sizes for BRRI dhan51 and BR11 cultivating farmers at Rangpur are 0.63 and 0.49 hectares, respectively. Also there is difference in land tenural status of the farmers in the two regions. Although the data suggest that land is rented in both the regions for cultivation, the farmers at Mymensingh borrowed less land compared to their farm owned land while farmers in Rangpur borrowed more land compared to their owned land. However, in both the regions the average farm size is larger for BRRI dhan51 growing farmers as compared to BR11 growing farmers. It means the larger farmers are adopting this new variety of rice more than small farmers.

Per hectare yield of the sample farmers

The yield of BRRI dhan51 is higher in Rangpur than Mymensingh but the yield of BR11 is higher in Mymensingh than Rangpur (Table 5). One of the reasons is the frequent flooding in Rangpur area. Due to having higher submergence tolerance capacity, the BRRI dhan51 yield was higher than BR11 in Rangpur. On the other hand in Mymensingh, the yields of both varieties were similar.

Comparative profitability of BRRI Dhan51 and BR11 rice

This section attempts to estimate and analyze the costs and returns of producing BRRI dhan51 and BR11 in the two areas under the study in order to find out their

Table 5 : Average yield of the sample farmers

Items	Rangpur		Mymensingh	
	BRRI dhan51 farmers	BR11 farmers	BRRI dhan51 farmers	BR11 farmers
Main product yield (Kg/ha)	5004.44	3235.53	4649.84	4492.18
By-product (Tk./ha)	2062.8	1526.50	6664.04	4921.88
Price of main product (Tk./kg)	28.26	19.20	20.00	16.48

Source: *Field Survey, 2010*

comparative profitability. Full cost and cash cost have been considered in calculating gross cost. Cash cost includes all cash expenses while full cost includes all cash and non-cash expenses including land use cost and interest on operating capital.

By comparing the cost and return between the two districts for the two varieties, it can be seen from table 6 that BRRI dhan51 was found to be highly profitable at both the locations. However, BRRI dhan51 was more profitable in Rangpur compared to Mymensingh and it was due to higher yield and higher price of paddy. The farmers of both areas used this paddy as seed and that was the reason for higher price of BRRI dhan51.

Estimated econometric models

At Rangpur, the estimated Cobb-Douglas type revenue function for BRRI dhan51 was:

$$\text{In}Y_1 = 3.285 + 0.110\ \text{In}X_1 + 0.350\ \ln X_2 + 0.202\ \ln X_3 + 0.043\ \ln X_4 + 0.215\ \ln X_5$$

Again the estimated production function for BR11 at Rangpur was:

$$\text{In}Y_2 = 1.480 + 0.107\ \text{In}X_1 + 0.220\ \ln X_2 + 0.103\ \ln X_3 + 0.028\ \ln X_4 + 0.173\ \ln X_5$$

At Mymensingh, the estimated Cobb-Douglas type revenue function for BRRI dhan51 was:

$$\text{In}Y_1 = 3.835 - 0.077\text{In}X_1 + 0.117\ \ln X_2 + 0.009\ \ln X_3 + 0.\ 504\ \ln X_4 + 0.485\ \ln X_5$$

And the estimated production function for BR11 at Mymensingh was:

$$\text{In}Y_2 = 1.\ 440 + 0.\ 662\ \text{In}X_1 + 1.139\ \ln X_2 - 0.298\ \ln X_3 - 0.470\ln X_4 + 0.069\ \ln X_5$$

In the case of BRRI dhan51 cultivation at Rangpur, all the coefficients were

Table 6 : Comparison of Costs and Returns

Items	Value (Tk.)			
	Rangpur		Mymensingh	
	BRRI dhan51	BR11	BRRI dhan51	BR11
A. Gross Return	143488.27	63648.676	99660.84	78953.01
B. Variable cost				
Human labor	37003.52	32201.24	19378.14	23466.88
Power tiller	6036.87	5742.29	3702.68	2568.36
Irrigation	4814.01	4105.23	3643.53	2438.48
Seed	1469.2	2084.3	7144	844.75
Urea	2502.16	3298.21	1454.20	2457.03
TSP	-	4208.82	-	283
MP	-	1475.95	-	-
Miscellaneous cost	850.00	625.00	850.00	1500.00
Total variable cost	52675.76	53741.64	36172.55	33558.50
C. Fixed cost				
Interest on operating capital	1152.16	915.15	1100	915
Land rental cost	2093.00	1529.00	1750	1500
Total Fixed cost	3245.16	2444.15	2850	2415
D. Gross cost (B+C)	55920.92	56185.79	39022.55	35973.50
E. Gross margin (A-B)	90812.51	9907.036	63488.29	45934.51
F. Net Return (A-D)	87567.35	7462.89	60638.29	42979.51
G. Undiscounted benefit Cost Ratio (A/D)	2.57	1.13	2.55	2.19

Source: *Field Survey, 2010*

significant at 5 percent level of significance (Table 7). The regression coefficient of human labor, seed, fertilizer, irrigation, power tiller cost were 0.110, 0.350, 0.202, 0.040 and 0.215 indicating that an increase of 1 percent of human labor, seed, fertilizer, irrigation, power tiller cost, keeping other factors constant, would result in an increase in gross return by 0.110, 0.350, 0.202, 0.040 and 0.215 percent, respectively.

In the case of BR11 cultivation also, all the coefficients were significant at 5 percent level of significance. The regression coefficient of human labor, seed, fertilizer, irrigation and power tiller cost were 0.107, 0.220, 0.103, 0.040 and

Table 7 : Coefficients of Cobb-Douglas type revenue function

Explanatory variable	Estimated Coefficient			
	Rangpur		Mymensingh	
	BRRI dhan51	BR11	BRRI dhan51	BR11
Constant	3.285	1.480	3.835	1.440
	(0.621)	(0.724)	(0.353)	(0.288)
Human labor cost (X_1)	0.110**	0.107**	-0.077	0.662*
	(0.052)	(0.043)	(0.081)	(0.323)
Seed cost (X_2)	0.350**	0.220**	0.117**	1.139*
	(0.150)	(0.086)	(0.034)	(0.512)
Fertilizer cost (X_3)	0.202**	0.103**	0.009	-0.298
	(0.080)	(0.047)	(0.133)	(0.354)
Irrigation cost (X_4)	0.040**	0.028**	0.504*	-0.470*
	(0.012)	(0.013)	(0.212)	(0.222)
Power tiller cost (X_5)	0.215**	0.173**	0.485**	0.069
	(0.098)	(0.080)	(0.154)	(0.081)
R^2	0.75	0.65	0.74	0.51
Adjusted R^2	0.65	0.50	0.65	0.50
F-value	6.961	4.472	5.86	3.71
Returns to scale	0.92	0.63	1.04	1.10

Source: *Field Survey, 2010* *Note: Figures in the parentheses indicate standard error*

* *Significant at 1 percent level*

** *Significant at 5 percent level*

0.173 indicating that an increase of 1 percent human labor, seed, fertilizer, irrigation and power tiller cost, keeping other factors constant would result in an increase in gross return by 0.107, 0.220, 0.103, 0.040 and 0.173 percent, respectively.

At Mymensingh, on the other hand, all the coefficients of the explanatory variables in Cobb-Douglas type revenue function were not statistically significant at 5 percent level for BRRI dhan51 cultivation. Only the coefficients of seed cost, irrigation cost and power tiller cost were significant. In the case of BR11 production at Mymensingh, the coefficients of human labour cost, seed cost and irrigation cost were significant.

It can be concluded from the above findings that the coefficients of human labour cost, seed cost, fertilizer cost, irrigation cost and power tiller cost were positive and significant at 5 percent level of significance at Rangpur. The results indicated rational use of inputs for BRRI dhan51 cultivation in Rangpur. However, at Mymensingh, only the coefficients of seed cost, irrigation cost and power tiller cost were significant at 5 percent level of significance and the rest were non-significant. This indicates rational use these inputs.

Adoption patterns and tracking varietal adoption scenario of BRRI Dhan51

Factors Affecting Adoption of BRRI dhan51

In the socioeconomic profile chapter, it was observed that BRRI dhan51 cultivating farmers were more educated than BR11 cultivating farmers. So, education can be one of the factors influencing farmer's decision of adopting BRRI dhan51. Some other factors that may influence the adoption of BRRI dhan51, as gathered from interviews of the farmers, are discussed below.

Resistance to Submergence

BRRI Dhan51 can survive up to 10 to 14 days of complete submergence at vegetative stage. Its production may still be 4 to 4.5 tons per hectare despite the submergence, while BR11 or other competing aman varieties can be completely destroyed due to such submergence. All the farmers interviewed in Mymensingh and 96.67 percent farmers interviewed in Rangpur identified this reason to be the main factor for cultivating BRRI dhan51.

Higher Yield

All the farmers under this study at both the locations identified high yield to be one of the important reasons for cultivating BRRI dhan51. As mentioned earlier, the normal yield for BRRI dhan51 is 5 to 5.5 tonnes per hectare, and when submerged for 10-14 days, the yield is still 4 to 4.5 tonnes per hectare. This is quite high for a HYV of aman in Bangladesh. So the yield is one of the factors responsible for adopting BRRI dhan51 by the farmers.

Less Fertilizer and Insecticides

BRRI dhan51 requires less fertilizer and insecticides compared to other aman varieties. So the cost of production is lower. All the farmers under this study have identified this as a reason for adopting BRRI dhan51.

Good Taste

The rice cooked from BRRI dhan51 tastes delicious. Hundred percent of farmers in Mymensingh and 96.67 percent of farmers in Rangpur have identified this to be another factor for cultivating BRRI dhan51.

Tracking varietal adoption scenario of BRRI Dhan51

To examine the varietals tracking system of BRRI dhan51 and BR11 growing farmers, the varietals tracking system of the sample farmers was divided into four categories. These are (i) (0 - 1) km (ii) (1.5- 2.5) km (iii) (3- 4.5) km and (iv) 5 km and above.

Table 8 shows that in the two study areas 51.67 percent BRRI dhan51 rice producers got their seed from a distance of less than a kilometer from their house. About 28.33 percent farmers got seed from a distance of 5 kilometer and above.

Table 8 : Tracking varietal adoption scenario of BRRI dhan51 and BR11

Distance	Rangpur		Mymensingh		Both districts combined	
	BRRI dhan51 farmers	BR11 farmers	BRRI dhan51 farmers	BR11 farmers	BRRI dhan51 farmers	BR11 farmers
	%	**%**	**%**	**%**	**%**	**%**
(0 - 1) km	6.67	16.67	96.67	0	51.67	8.33
(1.5- 2.5) km	16.67	23.33	0	100	8.33	61.67
(3- 4.5) km	23.33	50	0	0	11.67	25
5 km and above	53.33	10	3.33	0	28.33	5
Total	100	100	100	100	100	100

Source: *Field survey, 2010*

The rest of the BRRI dhan51 cultivators got their seed between 1.5 to 4.5 kilometers of distance from their house. On the other hand, vast majority of BR11 growing farmers (61.67 percent) got their seed from a distance of 1.5 to 2.5 kilometers, whereas 8.33, 25 and 5 percent of the BR11 farmers got their seeds from distances of 0-1 kilometer, 3-4.5 kilometer and 5 km and above, respectively. The results suggest that although adoption of BRRI dhan51 was more concentrated to sources of seed, farmers from distant places were also interested to grow BRRI dhan51 in their land. So they collected seed from long distances when necessary. It suggests that BRRI dhan51 has the potential to spread rapidly in the regions under this study.

However, by looking at the combined figure for the two regions, the specific scenario for each region may not be understood. So, it is essential to look into the data for each region separately, which also available in table 4.6. In Rangpur, the table shows that 53.33 percent BRRI dhan51 rice producers got their seed from a distance of 5 km and above from their house. About 23 percent farmers got seed from a distance of (3- 4.5) km, 16.67 percent got seed from distances of (1.5- 2.5) km, and 6.67 percent got seed from distances of (0 - 1) km. On the other hand, about a half of BR11 growing farmers got their seed from a distance of 3 to 4.5 kilometers while 16.67, 23.33 and 10 percent of the BR11 farmers got their seeds from distances of 0-1 kilometer, 1.5-2.5 kilometer and 5 kilometer and above, respectively. Farmers are very much interested to receive this BRRI dhan51 seed to grow in their land. They collected seed from long distances and with very high price. So it is clear that BRRI dhan51 has the potential to spread rapidly in this study region.

In the case of Mymensingh, Table 7 shows that in the study area 96.67 percent BRRI dhan51 rice producers got their seed from a distance of less than a kilometer from their house and only 3.33 percent got from a distance of 5 kilometer or above. On the other hand all the BR11 growing farmers got their seed from a distance of 1.5 to 2.5 kilometers. The results indicate that farmers under study in Mymensingh had been using seed from sources close to their home.

5. Conclusions

Flood is the main problem for aman rice cultivation, which usually occur during the monsoon season in Bangladesh. Many parts of the country submerge under water after aman is transplanted, destroying the standing crops. BRRI dhan51 is a rice variety which can withstand submergence for 10 to 14 days and still produce an yield of 4 to 4.5 tons per hectare. This study was undertaken to judge the profitability of BRRI dhan51 by comparing it with another rice variety which is cultivated during the same time at similar places and understanding the adoption scenario of BRRI dhan51. As BR11 is one of the most popular and widely cultivated aman high yielding varieties in Bangladesh, it was used as the check variety for this study.

The results observed that the yield of BRRI dhan51 is higher in Rangpur than Mymensingh but the yield of BR11 is higher in Mymensingh than Rangpur (Table 5). One of the reasons is the frequent flooding in Rangpur area. Due to having the submergence tolerance capacity, the BRRI dhan51 yield is better than BR11 in Rangpur. On the other hand in Mymensingh, the yields of both varieties are similar.

It is found that BRRI dhan51 cultivation was more profitable than BR11 in both the study areas. At Rangpur, the net returns from cultivating BRRI dhan51 and BR11 were estimated to be Tk. 87567.35 and Tk. 7462.89, respectively. At Mymensingh, the net returns were Tk. 60638.29 and Tk. 42979.51, respectively, for BRRI dhan51 and BR11. The BCR for BRRI dhan51 was 2.57 as compared to 1.13 for BR11 at Rangpur and the BCR for BRRI dhan51 was 2.55 as compared to 2.19 for BR11 at Mymensingh.

The profitability analysis of BRRI dhan51 cultivation through Cobb-Douglas type revenue function showed that the coefficients of human labour cost, seed cost, fertilizer cost, irrigation cost and power tiller cost were positive and significant at 5 percent level of significance at Rangpur. The results indicated rational use of inputs for BRRI dhan51 cultivation in Rangpur. However, at Mymensingh, only the coefficients of seed cost, irrigation cost and power tiller cost were significant at 5 percent level of significance and the rest were insignificant. This indicates that in Mymensingh, the farmers have more scope to use inputs efficiently.

The study also revealed that resistance to submergence, high yield, good taste and requirement of less fertilizers were the main reasons for farmers adopting BRRI dhan51 at both the locations. The analysis of tracking varietal adoption scenario of BRRI dhan51 suggests that although adoption of the variety was more concentrated to sources of seed, farmers from distant places were also interested to grow it in their land. So they collected seed from long distance. It implies that BRRI dhan51 has the potential to spread rapidly in the regions under study. So, it was observed that apart from being a submergence tolerant variety, BRRI dhan51 was also profitable as compared to BR11. Farmers can greatly benefit by cultivating the variety during the aman season.

References

1. BBS (2010). *Statistical Year Book of Bangladesh*. Bangladesh Bureau of Statistics, Ministry in Planning, Government of the Peoples Republic of Bangladesh, Dhaka
2. BRRI (2012a). "Bangladesh Rice Knowledge Bank". Bangladesh Rice Research Institute. Available online: http://www.knowledgebank-brri.org/.
3. BRRI (2012b). "Fact Sheet 49: Aman rice variety- BRRI dhan51, Rice Production Training Module", Bangladesh Rice Research Institute.
4. Gujarati, D.N. (1995). *Basic Econometrics*. 3rd edn. McGraw Hill Inc, New York.
5. IRRI (2006). "Rice Almanac". International Rice Research Institute, Manila. Philippines.
6. Jabbar, M. A. and Alam, M. S. (1993). "Adoption of modern Rice varieties in Bangladesh". *Bangladesh Journal of Agril. Econ*. 16(2), p. 77-95.
7. Sarwer, H. M. (2003). "A Comparative economic analysis BR-28 and Hybrid Hira paddy in Fulbaria Thana of Mymensingh District. M.S. Thesis, Submitted to the Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh.

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 025-044
Bangladesh Economic Association
(ISSN 2227-3182)

Small-scale Commercial Vegetables Farming and its Implications for Improving Livelihoods of C*har* People

SAKIB HASSAN*
MAHBUB HOSSAIN**
TOFAZZAL HOSSAIN MIAH**

Abstract *The study was designed to evaluate the profitability of small-scale commercial okra and snake gourd farming in two adjacent Char villages under Sadar Upazila of Mymensingh district. In total 60 farmers, 30 for okra and 30 for snake gourd growers, were randomly selected for the study. Activity budgets, descriptive statistics and Cobb-Douglas production function model were applied for analyzing the primary data. The findings of the study revealed that small-scale farming of both okra and snake gourd was highly profitable from the viewpoint of individual farmers. However, okra cultivation was more profitable than the cultivation of snake gourd. The study clearly indicated that per hectare gross returns were significantly influenced by the use of human labour, tillage, seeds, fertilizers and irrigation. These factors were directly or jointly responsible for influencing per hectare gross returns of both okra and snake gourd. Nevertheless, farmers growing both these vegetables were facing some problems and constraints in conducting small-scale commercial vegetables farming in the Char area of Mymensingh district. These problems included shortage of financial capital, high prices of inputs, low prices of output, lack of quality seeds, inadequate extension services, etc. Finally, some recommendations were made for improving cultural and management practices for the selected commercial vegetables farming. Thus, Char people can earn more household income for improving living standard by applying improved practices in okra and snake gourd cultivation.*

* The author is a post-graduate student. The article is based on the author Master thesis submitted to the Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh, Bangladesh.

** The authors are Assistant Professor and Professor, respectively, in the Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh.

1. Introduction

The agro-climatic conditions of Bangladesh are suitable for the cultivation of a large variety of crops but 80.0 percent of the gross cropped areas are at present confined to the production of rice and wheat. The increase in the production of rice and wheat, however, will not be sufficient to meet the food requirements of the fast growing population of Bangladesh. Food grain production led to an adverse effect on the acreage and production of vegetables. As a consequence, Bangladesh is not self-sufficient in vegetables production; and most people have been suffering from severe malnutrition for a quite long time. It is often argued that an addition of vegetables to the dietary menu is a must to maintain sound health of its people.

In Bangladesh, around 70.0 percent of total vegetables production take place in winter season. As a result, the consumption of vegetables is relatively lower in the summer season than in the winter. Under the circumstances, production of summer vegetables needs to be increased. The Government of Bangladesh has given more emphasis on year round vegetable production in order to meet the nutritional and caloric need of the growing population and for increasing employment opportunities and income of farmers. Okra and snake gourd that are grown in the summer season may provide such opportunities. It may be noted here that these vegetables were usually grown in the homestead area under traditional technology, but small-scale commercial okra and snake gourd farming has of late been started in the *Char* area following improved technology during the summer season. Unfortunately, no economic studies on profitability of commercial vegetables farming have yet been conducted in this area.

Prior to giving emphasis on the production of summer vegetables, it requires relevant and adequate information on different aspects of production at farm level. Such knowledge of production is also necessary to make appropriate decision by the growers especially when several alternatives are available to them. No systematic economic investigations on these vegetables have been undertaken either by the government or private organizations in order to satisfy the demand of extension workers, policy makers, research personnel, Non-Government Organization (NGO) officials and the farmer.

For this reason, the present study makes an attempt to analyze and compare the relative profitability of okra and snake gourd production. The study would identify the major factors that affect the yield of these vegetables. Farmers would be benefited from this study for effective operation and management of their farms. This study will be helpful to the researchers for further studies of similar nature and to the extension personnel, who are directly involved in agricultural development, and to the planners for making effective and judicious plan for the country. This study also may help extension workers to learn the various problems of the selected vegetables growers so that they will be equipped with adequate knowledge for giving suggestions to the farmers.

2. Research Methods

Study Area and Sample Size

Since small-scale commercial vegetables farming has recently been started in the *Char* area, two adjacent villages namely *Char* Shirta and *Char* Kharicha of Shirta union under Sadar Upazila of Mymensingh District were purposively selected for the study. In total 60 farmers, 30 for okra and 30 for snake gourd, were randomly selected for collecting primary data. A draft survey schedule was prepared and pretested by interviewing a few vegetables growing farmers of the study area. Thus, the draft schedule was improved, rearranged and modified in light of the actual and practical experience gathered from the study villages. After making necessary adjustments, a final survey schedule was developed and primary data were collected. Data entry was made in computer and analyses were done using the concerned software Microsoft Excel and Statistical Package for Social Science (SPSS). The study covered the whole summer vegetable season (April to August) of 2012. However, formal data were collected during the period from February to March 2013.

Analytical techniques

Activity Budget

Activity budget (see Dillon and Hardaker, 1993) was prepared and this technique was applied with the help of some descriptive statistical measures like the sum, average, percentages, etc. To assess per hectare profitability of the selected small-scale okra and snake gourd farming, the following algebraic equation was followed:

$$\eta \quad = TR - TC$$

$$\eta \quad = \sum Q_y.P_y + \sum Q_b.P_b - \sum_{i=1}^{n}(Xi.Pxi) - TFC$$

Where,

η = Net returns from okra/snake gourd (Tk/ha);

Q_y = Total quantity of (okra/snake gourd) outputs (kg/ha);

P_y = Per unit prices of the okra/snake gourd (Tk/kg);

Q_b = Total quantity of the concerned byproducts (kg/ha);

P_b = Per unit prices of the relevant byproduct (Tk/kg);

X_i = Quantity of the concerned i^{th} inputs;

P_{xi} = Per unit price of the relevant i^{th} inputs;

TFC = Total fixed cost involved in production of okra/snake gourd;

i = 1,2,3, ... η (number of inputs).

Cobb-Douglas production function model

Cobb-Douglas production function model was chosen to estimate the effects of key variables in the production process of okra and snake gourd. The double log form of the Cobb-Douglas production function model proved to be a superior alternative on theoretical and econometric grounds.

The Cobb-Douglas production function model has the following characteristics:

1. The function is linear in logs;
2. The exponents are the elasticity of production and can be estimated directly;
3. Total variations in the output explained by the selected inputs are measured by co-efficient of multiple determination;
4. The individual co-efficient represents relative factors share if there is constant returns to scale; and
5. For testing the significance level of individual co-efficient having sufficient degrees of freedom, 1 percent, 5 percent and 10 percent probabilities are used.

The specification of the Cobb-Douglas production function model was as follows:

$$Y = a\, X_1^{\,b_1}\, X_2^{\,b_2}\, X_3^{\,b_3}\, X_4^{\,b_4}\, X_5^{\,b_5}\, X_6^{\,b_6}\, X_7^{\,b_7}\, X_8^{\,b_8}\, u_i$$

By taking log in both sides the Cobb-Douglas production function was transformed into the following logarithmic form, because it could be solved by the ordinary least squares (OLS) method.

$$\text{Ln } Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + \ldots + b_8 \ln X_8 + Ui.$$

Where,

Y = Return per hectare (Tk/ha);

$\ln a$ = Intercept of the function;

X_1 = Human labour cost (Tk/ha);

X_2 = Tillage cost (Tk/ha);

X_3 = Seed/Seedling cost (Tk/ha);

X_4 = Urea cost (Tk/ha);

X_5 = MOP cost (Tk/ha);

X_6 = TSP cost (Tk/ha);

X_7 = Irrigation cost (Tk/ha);

X_8 = Insecticide cost (Tk/ha);

$b_1, b_2, \ldots, b_8$ = Coefficients of the respective input to be estimated; and Ui = Error term.

Detailed information on the selected model and its interpretations are given in Section IV.

Major Cost Items

Estimation of cost was exclusively necessary for enterprise costing and subsequently determining the profitability of the enterprise from the viewpoint of individual farmers. Farmer's decision about production is mainly influenced by the cost of inputs. Both purchased and family supplied inputs were used by the farmers of the study area. Thus the total production costs consisted of cash and non-cash expenses. Farmers had to pay cash for the purchased inputs like hired labour, seeds, fertilizers, insecticides, irrigation water charge, etc. It was very easy to calculate the costs of these items. On the other hand, for the home supplied inputs (for example, family labour) costs were estimated by applying the opportunity cost principle. A list of cost items that have been used in the selected vegetable growing farms are: (i) Human labour cost; (ii) Power tiller cost; (iii) Seed cost; (iv) Fertilizers; (v) Manure and oilcake; (vi) Insecticides; (vii) Irrigation water; (viii) Fencing cost; and (ix) Interest on operating capital.

3. Results and Discussion

The costs, returns and profitability of small-scale commercial okra and snake gourd per hectare farming are presented in this section.

Profitability of Commercial Okra Farming

Activity budgets, as stated before, have been prepared to assess the profitability of the concerned vegetables of the selected farmers. To obtain the net return, at first the cost of production and then the value of output (gross return) have been calculated. The net return can be obtained by deducting the gross costs from its gross returns. Costs are the expenses incurred in organizing the production process (Doll and Orazem 1984). The results of the estimation of the costs and returns of commercial okra farming are presented in Table 1.

Table 1 shows that the small-scale commercial okra farming is highly profitable from the viewpoint of individual farmers. In fact, farmers were earning Tk 86645.00 per hectare from commercial okra farming. Farmers had to spend Tk 138355.0/ha for conducting the small-scale commercial okra farming; but the highest cost (Tk 105,000.00/ha) was incurred for human labour (family plus hired) cost, which represented 75.88 percent of total gross costs of production of per hectare okra (Figure 1). In other words, commercial okra farming has created employment opportunity for a lot of resource-poor *Char* people, including farm family members. Since the *Char* people were working in commercial vegetable farming, they were earning an attractive amount of extra money during the summer season. Thus, both producers and resource-poor people as day lobourers were making extra income due to adoption of commercial vegetable farming in *Char* area during the summer season.

The undiscounted Benefit-Cost Ratio (BCR) is a relative measure which is used to compare benefits per unit of cost. It helps to analyze the financial efficiency of the farmers. This undiscounted BCR was calculated as a ratio of per hectare gross returns and gross costs. Table 1 reveals that BCR (undiscounted) of okra is 1.63 indicating that production of okra is highly profitable from the viewpoint of individual farmers in the *Char* area of Mymensingh district.

Profitability of Commercial Snake Gourd Farming

Table 2 shows that small-scale commercial snake gourd farming is also profitable from the viewpoint of individual farmers of *Char* area. For producing snake gourd farmers had to spend altogether Tk 169058.0 per hectare, while its gross return was

Table 1 : Activity Budgets: Per Hectare Okra Production in Summer Season

Items of returns/costs	Total quantity/ha	Per unit price (Tk)	Returns/costs (Tk/ha)	% of total
A. Gross Returns				
Main product	22000 kg	10.00	220000.00	97.78
By-product	n.a	-	5000.00	2.22
Total returns	-	-	225000.00	100.00
B. Variable Costs				
Human (hired) labour	250 Man-day	300/Man-day	75000.00	54.20
Human (family) labour	100 Man-day	300/Man-day	30000.00	21.68
Power tiller	3 times	7.0/decimal	5187.00	3.75
Seeds	3 kg	400/kg	1200.00	0.87
Urea	200 kg	22/kg	4400.00	3.19
TSP	70 kg	25/kg	1750.00	1.27
MOP	70 kg	15	1050.00	0.76
Cow dung	9000 kg	1/kg	9000.00	6.50
Insecticides	n.a	-	4500.00	3.25
Irrigation charge	n.a	-	4000.00	2.90
Total			136087.00	98.36
C. Fixed Costs				
Interest on OC	-	@10%	2268.00	1.64
Total			2268.00	1.64
D. Gross costs (B+C)			138355.00	100.00
F. Net Return (A-D)			86645.00	
G. Undiscounted BCR			1.63	

Source: *Adapted from Hassan (2013, p. 53)*

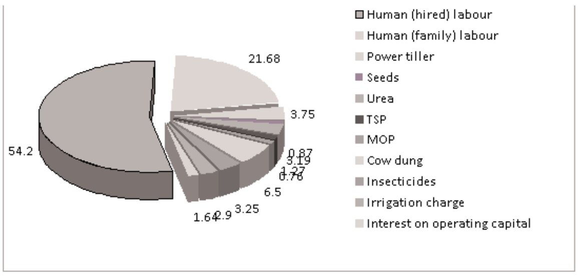


Figure 1 : Pie Chart Showing Percentage Share of Cost Item for Okra

Tk 240000.0 per hectare. Thus, its net return or profit was Tk 70942.0 per hectare during the summer season. Table 2 reveals that BCR (undiscounted) of small-scale commercial snake gourd farming was 1.42. This implies production of small-scale commercial snake gourd was highly profitable from the viewpoint of individual investors in *Char* area. It may be noted here that 420 man days (both family and hired labour) per hectare were required for conducting small-scale commercial snake gourd farming in *Char* area. In other words, a greater proportion of money had to be spent for human labour costs, which represents 74.52 percent of total gross costs of per hectare snake gourd production (Figure 2).

Table 2 : Activity Budgets: Per Hectare Snake Gourd Production in Summer Season

Items of returns/costs	Total quantity/ha	Per unit price (Tk)	Returns/costs (Tk/ha)	% of total
A. Gross Returns				
Main product	20000.00 kg	12.00	240000.00	100.00
Total returns	-	-	240000.00	100.00
B. Variable Costs				
Human (hired) labour	300 Man-day	300/Man-day	90000.00	53.23
Family labour	120 Man-day	300/Man-day	36000.00	21.29
Power tiller	3 times	7.00/decimal	5187.00	3.08
Seeds	3 kg	600/kg	1800.00	1.06
Urea	250 kg	22/kg	5500.00	3.25
TSP	120 kg	25/kg	3000.00	1.78
MOP	120 kg	15/kg	1800.00	1.06
Cow dung	9000 kg	1/kg	9000.00	5.32
Insecticides	n.a	-	4500.00	2.67
Irrigation charge	n.a	-	4500.00	2.67
Fence and *Mancha*	n.a	-	5000.00	2.96
Total			166287.00	98.36
C. Fixed Costs				
Interest on OC	-	@10%	2771.00	1.64
Total	-	-	2771.00	1.64
D. Gross costs (B+C)			169058.00	100.00
F.Net Return (A-D)			70942.00	
G. Undiscounted BCR			1.42	

Source: *Adapted from Hassan (2013, p. 58).*

The undiscounted BCR of snake gourd production, as shown in Table 2, was 1.42. This result also indicates that investment in commercial snake gourd farming in *Char* area is highly remunerative to the individual investors. Once again, resource-poor people as day labourers, were earning income by engaging themselves in commercial vegetables farms in *Char* area. In a word, both vegetables farmers and day labourers were benefiting from the adoption of commercial vegetables farming in *Char* area; and their livelihoods status has improved much better than ever before.

Comparison of Commercial Okra and Snake Gourd Farming

The summary results of yield, gross return, gross cost and net return per hectare and BCR (undiscounted) of okra and snake gourd are presented in Table 3. It shows that per hectare yield and net returns of okra (Figure 3) were much higher

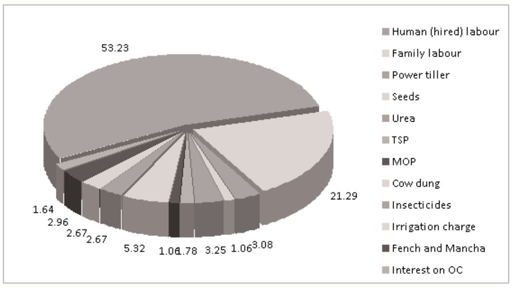


Figure 2 : Pie Chart Showing Percentage Share of Cost Item for Snake Gourd

than those of the snake gourd farming. The cost of production per hectare snake gourd farming was higher than that in okra (Table 3 and Figure 3). Similarly, BCR of okra was much higher than that of the snake gourd farming. From these discussions it is clear that both okra and snake gourd farming were profitable, but okra was more profitable than the snake gourd production in the *Char* area. Thus, the standard of living of farmers as well as resource-poor people would be increased substantially since commercial vegetables farming are highly remunerative to the *Char* people.

4. Factors Affecting the Vegetables Production

Production function is a relation (or mathematical relationship) specifying the maximum output that can be produced with given inputs for a given level of

Table 3 : Relative Profitability of Growing Okra and Snake Gourd per Hectare

Particulars	Okra	Snake gourd
Yield (kg/ha)	22000.00	20000.00
Gross return (Tk/ha)	225000.00	240000.00
Gross costs (Tk/ha)	138355.00	169058.00
Net returns (Tk/ha)	86645.00	70942.00
BCR (Undiscounted)	1.63	1.42

Sources: *Adapted from Tables 1 and 2.*

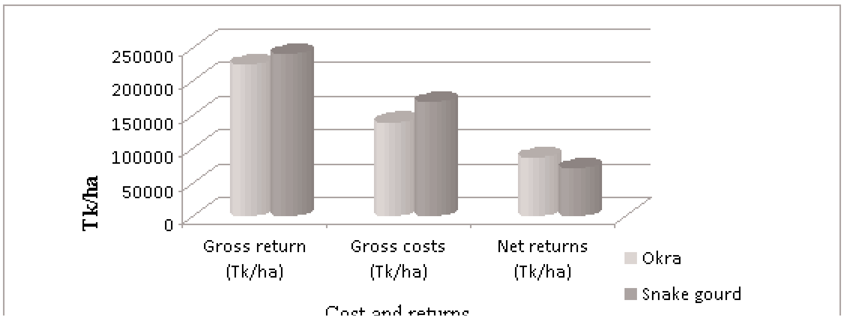


Figure 3 : Relative Profitability of Growing per Hectare Okra and Snake Gourd

technology. It applies to a firm or as an aggregate production function to the economy as a whole (Samuelson and Nordhaus 1995). Considering the effects of explanatory variables on yield of okra and snake gourd, eight explanatory variables, namely human labour cost (X_1), tillage cost (X_2), seeds cost (X_3), Urea cost (X_4), MOP cost (X_5), TSP cost (X_6), irrigation cost (X_7) and insecticides cost (X_8) were chosen as key independent factors to estimate the quantitative effect of inputs on yield of okra and snake gourd, respectively. All these variables have been estimated as per hectare monetary values. However, other important variables such as management, land quality, soil type, sowing time and weather etc., were excluded in the analysis due to paucity of reliable data. To explore the input output relationships production function was fitted. Of possible statistical forms, Cobb-Douglas production function, most popular in farm-firm analysis, was used as this algebraic model provides a compromise (a) adequate fit of the data, (b) computation feasibility, and (c) sufficient degrees of freedom unused to allow for statistical testing. In other words, the Cobb-Douglas is a relatively "efficient user" of degrees of freedom (Heady and Dillon 1961).

Another special advantage of using Cobb-Douglas production function model was that the regression under OLS in logarithm yields coefficients, which represents partial elasticities of production and if all the inputs related to the production are taken into account, the sum of the elasticities indicates whether the production process as a whole yields increasing, constant or decreasing returns to scale. It is therefore widely used by many researchers in their economic studies. The advantages of the model are that it is simple to calculate and the elasticity of production can directly be obtained from the coefficient.

Interpretations of the Results of Okra Farming

Human labour cost (X_1). The magnitude of the regression coefficient of human labour cost was 0.142 with a positive sign. It was significant at one percent probability level. It implies that a one percent increase in human labour cost, keeping other factors constant, would lead to an increase in the gross return by 0.142 percent for okra (Table 4).

Tillage cost (X_2). Table 4 shows that regression coefficient of tillage cost was 0.153 for okra. It was positive and significant at five percent probability level. This indicates that an increase by one percent in tillage cost, other factors remaining constant, would result in an increase in the gross return by 0.153 percent.

Seed cost (X_3). Table 4 indicates that the regression coefficient of seed cost was 0.166 for okra. It was positive and significant at ten percent probability level. This indicates that an increase by one percent in seed cost, other factors remaining constant, would result in an increase in the gross return by 0.166 percent.

Urea cost (X_4). The regression coefficient of Urea cost was 0.175 for okra. It was positive and was significant at five percent probability level. This indicates that an increase in one percent of Urea cost, other factors remaining constant, would result in an increase in the gross return of okra by 0.175 percent (Table 4).

MOP cost (X_5). The regression co-efficient of MOP cost was 0.291, which was significant at five percent probability level. It indicates that a one percent increase of MOP cost, on an average, significantly increased gross return by 0.291 percent for okra keeping all other factors remaining constant (Table 4).

TSP cost (X_6). The regression co-efficient of TSP cost was -0.05 which was statistically not significant. Moreover, its negative sign indicated an inverse relationship between gross return and TSP cost. That means, in response to a one percent increase in TSP cost, on an average, gross return for okra would be decreased by 0.05 percent (Table 4).

Irrigation water cost (X_7). The magnitude of the regression coefficient of irrigation water cost was 0.014 for okra. This indicates that a one percent increase in irrigation water cost, other factors remaining constant, would result in an increase in the gross return by 0.014 percent (Table 4).

Insecticides Cost (X_8). Table 4 indicates that regression coefficient of insecticides cost was 0.036. This indicates that an increase by one percent of insecticides cost, other factors remaining constant, would result in an increase in the gross return by 0.036 percent.

Coefficient of multiple determination (R^2). It is evident from Table 4 that the value of the coefficient of multiple determination (R^2) was 0.826 for okra. It indicates that about 82 percent of the variations of the gross returns are explained by the explanatory variables included in the model.

Goodness of fit (F - value). The F-value was 58.968 for okra, and the estimated production was significant at one percent probability level (Table 4), which implies good fit of the model. That is, all the explanatory variables included in the model were important for explaining variation of okra production.

Returns to scale (bi). The summation of all the regression coefficients or production elasticities of the estimated model gives information about the returns to scale, that is, in the response of output to a proportionate change in all inputs. The sum of all the production coefficients of the equations for okra production was 0.927 (Table 4). This indicates that the production function exhibited decreasing returns to scale for the okra production.

Interpretations of the Results of Snake Gourd Farming

Human labour cost (X_1). The magnitude of the regression coefficient of human labour cost was 0.266. It was significant at one percent probability level. It implies that a one percent increase of human labour cost, keeping other factors constant, would lead to an increase in the gross return by 0.266 percent for snake gourd (Table 4).

Tillage cost (X_2). The vale of coefficient of tillage cost was 0.010 with a negative sign. It implies that one percent increase of tillage cost, keeping other factors constant, would lead to a decrease in the gross return by 0.010 percent for snake gourd (Table 4). This coefficient was not however statistically significant.

Seed cost (X_3). Table 4 indicates that the regression coefficient of seed cost was 0.030 for snake gourd. This indicates that an increase by one percent of seed cost, other factors remaining constant, would result in an increase in the gross return by 0.030 percent.

Urea cost (X_4). Table 4 shows that the regression coefficient of fertilizer cost was 0.360 for snake gourd. It was positive and was significant at one percent probability level. This indicates that an increase by one percent in fertilizer cost, other factors remaining constant, would result in an increase in the gross return by 0.360 percent.

MOP cost (X_5). The value of the coefficient of MOP cost was 0.180 with a positive sign (Table 4). It implies that one percent increase of MOP cost, keeping other factors constant, would lead to an increase in the gross return by 0.180 percent for snake gourd. This coefficient was, however, not statistically significant.

TSP cost (X_6). The regression co-efficient of TSP cost was 0.038 for snake gourd, which was positive but not statistically significant. The coefficient, however, indicates that in response to one percent increase of TSP cost, on an average, gross return would increase by 0.038 percent (Table 4).

Irrigation water cost cost (X_7). Table 4 indicates that the regression coefficient of irrigation water cost was 0.095 with a positive sign. This indicates that an increase by one percent of irrigation water cost, other factors remaining constant, would result in an increase in the gross return by 0.095 percent for snake gourd.

Insecticides cost (X_8). The value of the regression coefficient of insecticides cost, other factors remaining constant, would result in a decrease in the gross return by 0.024 percent for snake gourd. The coefficient has a negative sign, a possible cause of this negative sign might be the mismanagement and over-use of this input. Farmers can have better return per hectare by making efficient use of this input.

Coefficient of multiple determination (R^2). It is evident from Table 4 that the value of the coefficient of multiple determinations (R^2) was 0.768 for snake gourd. It indicates that about 76.0 percent of the variations of the gross return are explained by the explanatory variables included in the model.

Goodness of fit (F-value). The F-value was 15.426 for snake gourd. The estimated production function was significant at one percent probability level (Table 4), which implies good fit of the model. That is, all the explanatory variables included in the model were important for explaining the variation of snake gourd production.

Returns to scale (bi). The sum of all the production coefficients of the equations for snake gourd production was 0.935 (Table 4). It indicates that the production function exhibited decreasing returns to scale for snake gourd farming.

Table 4 : Estimated Values of Coefficients and Related Statistics of Cobb-Douglas Production Function Model for Okra and Snake Gourd Production

Explanatory variables	Commercial okra farming		Commercial snake gourd farming	
	Coefficients	t-value	Coefficients	t-value
Intercept/Constant	5.923 (0.891)	6.647	9.044 (1.179)	7.668
Human labour cost (X_1)	0.142*** (0.045)	3.181	0.266*** (0.078)	3.420
Tillage cost (X_2)	0.153** (0.055)	2.780	-0.010 (0.044)	-0.226
Seed cost (X_3)	0.166* (0.086)	1.932	0.030 (0.046)	0.061
Urea cost (X_4)	0.175** (0.063)	2.778	0.360 *** (0.102)	3.539
MOP cost (X_5)	0.291** (0.128)	2.273	0.180 (0.043)	4.186
TSP cost (X_6)	-0.05 (0.057)	-0.871	0.038 (0.094)	0.410
Irrigation cost (X_7)	0.014 (0.025)	0.557	0.095** (0.043)	2.211
Insecticide cost (X_8)	0.036 (0.158)	0.231	-0.024 (0.038)	-0.630
F-value	58.968		15.426	
R^2	0.826		0.768	
Returns to scale ($\sum$ bi)	0.927		0.935	

Note: *** = Significant at 1% level
** = Significant at 5% level
* = Significant at 10% level
Figures within parentheses indicate standard deviation.
Source: *Adapted from Hassan (2013, p. 65 and 68).*

Cobb-Douglas production function model revealed that the key variables included in the model were individually or jointly responsible for variation in the gross return or output of okra and snake gourd. It also revealed that okra and snake gourd growers allocated their resources in the zone of decreasing returns (i.e., in Stage II), which indicates that they were operating okra and snake gourd farming in the rational zone of production.

5. Problems of Commercial Vegetable Farming

An attempt is made in this section to identify major problems and constraints faced by farmers in conducting small-scale okra and snake gourd commercial farming. The problems and constraints are broadly classified into three categories:

(i) economic and technical problems; (ii) marketing problems; and (iii) social problems.

Economic and Technical Problems

Lack of financial capital

Since improved farming technique was followed in commercial vegetables farming, both okra and snake gourd farmers were facing a severe shortage of financial capital during the cultivation of okra and snake gourd. In the *Char* area financial condition of both okra and snake gourd growers were not so good. They did not have enough financial capital to conduct the selected vegetables farming since the production cost was much higher than the traditional homestead vegetables gardening. About 58.34 percent of total selected vegetables growers reported this problem (Table 5).

Lack of scientific knowledge

Many farmers did not have any scientific knowledge of commercial okra and snake gourd cultivation. Most farmers were illiterate. About 70.0 percent of the selected vegetables growers reported that the productivity of these vegetables was low due to lack of scientific knowledge about modern cultural practices.

Insufficient irrigation

Irrigation water was an important input for producing the selected vegetables. Because okra and snake gourd were produced in the summer season and, rain fall was very low in summer, farmers irrigated their vegetables by shallow tubewells (STWs). But in the study areas there were not enough STWs. About 30.0 percent vegetable growers had to face this problem (Table 5).

High prices of fertilizers and insecticides

Fertilizers and insecticides are vital inputs in the production of the selected vegetables. It was reported that the selected vegetables were often attacked by pests and diseases. About 63.0 percent of the selected vegetable growers reported that the availability of fertilizers and insecticides was scarce in local markets. For this reason price was a bit higher in *Char* area. Normally the prices situation of the material inputs was not too bad, but the situation aggravated in the peak cultivation period when the price of fertilizers, insecticides and pesticides went up overnight due to unfair profit making motive of retailers and wholesale dealers, who usually created an artificial crisis to create panic among the *Char* farmers.

Scarcity of good quality seeds

Availability of modem variety as well as quality seeds was another limiting factor in producing okra and snake gourd. On an average 51.67 percent vegetable farmers reported this problem. They said that in local market MV (modern variety) seeds were not available. Most growers purchased seeds but they opined that in many cases the seeds were not of good quality and the price of seeds was also too high during the sowing/planting period of vegetables.

Attack by pest and disease

It was reported that a considerable amount of yield of vegetables were lost by the attack of pests and diseases. In the study area, about 50.0 percent vegetable growers faced this problem.

Marketing Problems

Marketing was one of the serious problems of the commercial vegetables farmers. Most commercial farmers used to sell their products to the local *Paikars* at their farm-gates. As a consequence, they received much lower price for their products. A few farmers, of course, sold their products at the village market as well as town market. The commercial vegetables were fetching some marketing problems, which are highlighted below:

Low price of the products

The prices of selected vegetables in the peak harvesting period were very low. About 85.0 percent of the selected vegetables growers reported this problem. Many farmers were compelled to make distress sale in order to meet the urgent needs of cash for their day-to-day household expenditures that led to increase the supply of their products in the village market at harvesting period and thereby lowering the selling price per unit. Thus the production of the selected vegetables became less profitable to them (Table 5).

Carrying and handling problems

Due to carrying and handling problem the vegetables growers used to sell their product to local *Paikars* at the village markets and a few growers sold their products at farm-gate. Table 5 shows that about 37 percent of the selected vegetable growers treated carrying and handling as a serious problem. Farmers also reported that they could not take advantage of the higher price prevailing at distant markets due to lack of carrying and handling facilities. Adequate carrying and handling facilities at reasonable cost would improve the efficiency of vegetable marketing.

Table 5 : Problems and Constraints of Small-scale Commercial Okra and Snake Gourd Farming

Nature of problems	Okra		Snake gourd		Average of all farmers (%)
	No.	Percentage	No.	Percentage	
A. Economic and Technical Problems					
Lack of financial capital	17	56.67	18	60.00	58.34
Lack of scientific knowledge	20	66.67	22	73.33	70.00
Insufficient irrigation	10	33.33	08	26.70	30.01
High prices fertilizer and insecticides	18	60.00	20	66.67	63.34
Scarcity of good quality seeds	16	53.33	15	50.00	51.67
Attacked by pest and diseases	15	50.00	15	50.00	50.00
B. Marketing Problems					
Low price of products	25	83.33	26	86.67	85
Carrying and handling problem	10	33.33	12	40.00	36.67
C. Social Problems					
Damaged by domestic animals	10	33.33	06	20.00	26.67
Loss of product due to theft	12	40.00	16	53.33	46.67

Source: *Adapted from Hssan (2013, p. 78).*

Social Problems

It was found that farmers were facing some social problems in producing okra and snake gourd commercially. These are discussed below.

Vegetables damaged by stray animals

Farmers gathered an experience that in the early stage the plants were affected by stray cattle and goats. About 27.0 percent growers reported that their plots were affected by stray animals of influential people in the *Char* area.

Loss of production due to theft

In this *Char* area, theft of okra and snake gourd was a common phenomenon which discouraged the growers to grow these vegetables commercially. About 46.0 percent of the selected vegetable growers reported that their products were often stolen by unknown notorious people.

The discussions made above as well as the results presented in Table 5 indicate that commercial okra and snake gourd growers in the study area currently face some major problems in conducting commercial vegetables farming. The concerned authority must pay an immediate attention to solve these problems of commercial vegetables growers, which will increase the per unit yield of vegetables and enable farmers to have better income from commercial vegetables farming.

6. Conclusion and Recommendations

It can cautiously be concluded that a considerable scope apparently exists in the *Char* area to increase the productivity of okra and snake gourd and to increase income, employment and nutritional status of the farmers. The study reveals that small-scale commercial okra and snake gourd farming is highly profitable from the viewpoint of individual farmers in *Char* area of Mymensingh district. Thus, the small-scale commercial vegetable farming has had bright prospects and *Char* people can improve their standard of living by adopting improved vegetable farming instead of the so called traditional homestead vegetables gardening.

The management practices of selected vegetables production in the *Char* area were not found efficient enough due to some marketing problems. Farmers have had very little knowledge about the application of inputs in right time with right doses. Consequently, they made over or under use of some inputs. Thus, well planned management training in accordance with their problems, needs, goals and resource use can lead to viable production practices and sustainable income from commercial okra and snake gourd cultivation.

Policy Recommendations

It was evident that commercial okra and snake gourd production were highly profitable and they can generate income earning and employment opportunity to the most neglected resource-poor *Char* people of Mymensingh district. But some problems and constraints were barriers to attain the ultimate goals of the commercial vegetables growers. The following policy recommendations are likely to be useful for policy formulation:

(a) From actual field experience gained so far, it is gathered that there is an imbalance in the use of fertilizers in the study area. So public and private interventions might be required for (i) ensuring balanced use of fertilizers; (ii) encourage increasing use of organic and bio-fertilizers; and (iii) training the farmers by extension service people in using appropriate doses and combinations of fertilizers. Farmers often reported that they had to purchase adulterated fertilizers. Public initiative should be taken to maintain fertilizer quality.

(b) The commercial vegetables farmers can form producers cooperative and this cooperative society can purchase STWs to ensure irrigation facilities for commercial vegetables growers in the *Cha*r area.

(c) Operating capital is a serious problem for the commercial farmers of the study area. Institutional credit programme should be launched aiming particularly the commercial vegetables growers. The commercial banks should be encouraged to provide loans at a reasonable rate of interest to enable farmers to operate their farming on commercial basis.

(d) Farmers could not get reasonable prices for their vegetables. Marketing costs are high because of inadequate information, infrastructure, high price risks, etc. So steps should be taken to ensure: (i) fair price; (ii) quality of agricultural products; and (iii) floor price scheme for vegetables producers.

(e) Good quality of MV seeds in right quantity is recognized to be one of the key elements for enhancing vegetables production. Emphasis should be given on creating facilities and infrastructure support for hybrid seed production, marketing and development.

(f) Actual plant protection activities involve pest surveillance, monitoring and early warning against pest attacks, and rendering advisory service to farmers, traders and others dealing with pesticides and quality control of pesticides marketed by private sector. Agricultural extension workers are responsible for providing advice to the farmers about appropriate plant protection measures. The integrated pest management (IPM) programme should be expanded to keep okra and snake gourd free from pests and combat environmental degradation due to the use of pesticides. Training should be given to the farmers in the use of different plant protection measure by demonstration.

(g) Transfer of technologies and diversification and intensification of crop production programme through appropriate extension service are of crucial importance to Bangladesh agriculture. The extension service must be able to render the needed advice, management and technical support to the okra, and snake gourd growers at the appropriate time.

References

1. Bishop, C.E. and Toussaint, W.D. (1996), *Introduction to Agricultural Economic Analysis Willy,* New York.
2. Dillon, J.L. and Hardaker, J.B. (1993), *Farm Management Research for Small Farmer Development,* Food and Agriculture Organization of the United Nations, Rome.
3. Hassan, M.S. (2013), *"An economic analysis of okra and snake gourd production in selected Char areas of Mymensingh district".* MS Ag Econ (Production Economics) thesis, Bangladesh Agricultural University, Mymensingh.
4. Heady, E. O. and Dillon, J.L. (1961), *Agricultural Production Functions,* Iowa State University Press, Ames, Iowa.
5. Yang, W.Y. (1962), *Method of Farm Management Investigation,* Food and Agriculture Organization of the United Nations, Rome.
6. Samuelson, P.A. and Nordhaus, W.D. (1995), *Economics,* 18th edn, MacGraw Hill, New Delhi.
7. Zahar, M.A. (1995), *"Comparative economics of tomato and cauliflower: A study in a selected area of Bangladesh".* MS Ag. Econ thesis, Bangladesh Agricultural University, Mymensingh.

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 045-059
Bangladesh Economic Association
(ISSN 2227-3182)

Financial Profitability of Aromatic Rice Production and its Impacts on Farmers' Livelihood in selected areas of Tangail District

JANNATUL NASRIN*
MD. TAJ UDDIN**

Abstract *The focus of the study was to evaluate the financial profitability of aromatic rice production and its impacts on farmers' livelihood in selected areas of Tangail district. A total of 60 farmers of some selected areas of Tangail district were selected as sample for achieving objectives of the present study. To collect data, a questionnaire was administered through face-to-face interviews. Data were analyzed with descriptive statistics, partial budget analysis, multiple regression analysis and sustainable livelihood approach. The result of descriptive statistics revealed that the average family size of aromatic rice growers was higher than the national average. The undiscounted benefit -cost ratio of aromatic rice production was 1.61 implying that the aromatic rice production was profitable. Moreover, the result of partial budget analysis revealed that aromatic rice producers have higher income and better livelihood than those who are producing non-aromatic rice in the study area. Estimated values of the relevant coefficients of Cobb-Douglas production function revealed that among the included variables human labor, seed, fertilizer, power tiller and irrigation had significant impact and insecticides had insignificant impact on the per hectare output of aromatic rice production. Aromatic rice farmers claimed good health condition, better schooling and education and increasing saving in the study areas. The study also identified some problems faced by the farmers in producing aromatic rice and probable solutions relating to those problems. Finally, some policy recommendations based on the findings of the study were made.*

* M. S. in Agricultural Economics, Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202

** Professor, Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202

Introduction

Agriculture sector of Bangladesh is dominated by rice production. This sector contributes 20.01 percent to the gross domestic product (GDP) of which the crop sub-sector alone contributes 11.32 percent (BBS, 2011).Rice is the main item of food for the people of this country. Although the total land area is the same in each year, the total cultivated area is decreasing year to year due to industrialization. Rice is the principal cereal crop which occupies almost three-quarters of the total crop land. Rice production is vital to the Bangladesh economy. The experience of technological change led by varietals improvement in Bangladesh has significantly contributed to the growth of rice production during the last three decades. There are three seasons of rice grown which are known as Aus, Aman and Boro. The development of high-yielding modern grain varieties of rice, which are highly responsive to inorganic fertilizers and insecticides, effective soil management and water control, helped the country to meet the increasing requirement of food grain. Among the high-yielding varieties, Aman varieties had traditionally large share in the total production. In recent years, however, the share of Boro is increasing.

Fine and aromatic rice is a part of the rice family (*Oryza sativa* L.). Rice is an ancient and venerable grain that has been cultivated since at least 5000 B.C. Rice has a number of varieties. Among the rice varieties, aromatic rice is popular in Asia and gained wider acceptance in Europe and the United States because of their aroma, flavor and texture. Aromatic varieties fetch higher price in rice market than the non-aromatic ones. Demand for aromatic rice in recent years has increased to a great extent for both internal consumption and export (Das and Baqui, 2000).

Nearly 70% of the land area of the country has been brought under rice cultivation. Out of this 70% share, fine and aromatic rice is cultivated in roughly 10% land. This lower coverage is primarily due to the emphasis of government policy and research on food grain production but with low input technology. The government is more concerned about the basic staple rice of the country. As a result, very little support has been found to be on fine and aromatic rice. Consequently, the fine and aromatic rice cultivation accounts for only a marginal fraction of the total rice production in the country (Sarker and Biswas, 2002).

Rice is generally classified by its length, thickness, aroma, and whiteness. The length of long-grain rice is four to five times that of its width. One of the more exotic varieties in the long-grain category is the aromatic East Indian Basmati. Locally adapted varieties are Chiniatop, Kalizira and Kataribhog. BR34 and

BR38 are another two high valued rice varieties released by Bangladesh Rice Research Institute (BRRI), having small grain and pleasant aroma. However, Kalajira rice, although not in the longer category, has the most exotic aroma. The farmers grow fine rice primarily to take the advantage of higher revenue. This is because such cultivation requires very small dose of fertilizer, pesticides and irrigation. The per acre cost of production of fine rice is very low compared to coarse rice.

Ashrafuzzaman *et al.* (2009) revealed the growth performance and grain quality of six aromatic rice varieties BR34, BR38, Kalizira, Chiniatop, Kataribhog and Basmati grown under rainfed conditions; Raha (2006) performed a study to evaluate the profitability of production and marketing system of aromatic rice; Anik (2003) undertook a study to evaluate the economic and financial profitability of aromatic and fine rice production using both primary and secondary data.

In the past, some works were done about production and marketing of aromatic fine rice, including determination of financial costs and its profitability. However, the present study especially aims to do in depth analysis of profitability of aromatic rice and its impact on farmers' livelihood pattern. Therefore, this study is expected to provide meaningful information that can be of good use by the policy planners to increase the aromatic rice production and to improve farmers' livelihood pattern. The overall goal of the study is to analyze the profitability of aromatic rice production and its impact on farmers' livelihood pattern. The specific objectives are as follows:

i. To document the socioeconomic characteristics of the aromatic rice growers;
ii. To calculate the profitability of aromatic rice production;
iii. To determine the factors affecting the gross return of aromatic rice production;
iv. To assess the impacts of aromatic rice production on farmers' income and livelihood pattern.

Study Methods

The study was conducted in the villages namely, Maista, Nagarbari, Kurua, Tatihara, Tarabari, Maloti and Adabari under Kalihati Upazila of Tangail District. Total 60 farmers on the basis of farm size were selected following stratified random sampling. Among them are 20 farmers producing Kalijira, 10 farmers producing Tulsimala and 30 farmers producing BRRI dhan 34. Data were collected by the researcher herself in the month of February to April 2013. With a view to collecting primary data from the respondents, field survey was conducted by using a structured questionnaire. Secondary data and information were collected from different reports, publications, handouts, notifications, journals, books etc. having relevancy with this study. Collected data were classified, tabulated and analyzed to achieve the objectives set for the study. Both tabular and statistical techniques were used. Descriptive statistics (i.e., sum, average, percectage, ratios, etc.) were employed to achieve the objectives.

To explore the relationship between production and input, the Cobb-Douglas production function was used as follows:

$Y_i = aX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} e^{u_i}$

This was linearised in the logarithmic form as follows:

$InY = Ina + b_1InX_1 + b_2InX_2 + b_3InX_3 + b_4InX_4 + b_5InX_5 + b_6InX_6 + U_i$

Where,

Y =Gross return (Tk./ha);

X_1=Human labor cost(Tk./ha);

X_2=Seed cost (Tk./ha);

X_3= Power tiller cost (Tk./ha);

X_4=Fertilizer cost (Tk./ha);

X_5=Irrigation cost (Tk./ha);

X_6=Insecticides cost (Tk./ha);

Ln=Natural lorgarithm;

a =Constant/Intercept;

$b_1, b_2 \ldots\ldots\ldots\ldots\ldots b_6$ = production coefficients of the respective variables; and

U_i=Error term.

The partial budget was used to compare the positive and negative effects of the proposed change on net income. We separate the positive and negative effects and list them in different sections of the partial budget.

To accomplish the objective of profit maximization, i.e., for efficient allocation of resources, one should use more of the resources so long as the value of added product is greater than the cost of added amount of input producing it. The resources are considered to be efficiently used when the ratio of marginal value product (MVP) to marginal factor cost (MFC) approaches one, or in other words, MVP and MFC for each input are equal. The optimum use of a particular input would be ascertained by the condition of equality of MVP and MFC,

i.e., $MVP_{xi} / MFC_{xi} = 1$

If the ratio is greater than 1, the resource is sub-optimally used and the gross return could be increased by using more of the resource and it is less than the resource is over used and the excess use of resource should be decreased to minimize the loss.

The sustainable livelihood framework was used to improve our understanding of livelihood, particularly the livelihood of the poor. The livelihood framework identifies five core asset categories or types of capital upon which livelihoods are built. A sustainable livelihood is the outcome of inter and intra relationship between the components of the capitals. Increasing access which can take the form of ownership or the right to use these assets is a primary concern for Department for International Development (DFID) in its support of livelihoods and poverty elimination.

Result and Discussion

Socioeconomic Profile of Aromatic Rice Growers

Average size of family consisted of 4.9 of which 2.6 were male and 2.3 were female for all farmers (Table 1). Thus, the average family size of the sample farms was higher than the national average of 4.53 (HIES, 2010). The family members were classified into three groups i.e. (i) 0 to 14 years, (ii) 15 to 64 years, and iii) above 64 years (HIES, 2010). Thus, the majority of family members in all the farm categories were in the working age group of 15 to 64 years. The literacy rate for the family members of aromatic rice production is even higher in the national context, where the statistics of literacy is claimed to be 57.51 percent (HIES, 2010).

Table 2 shows that average farm size of aromatic rice growers was 0.95 hectare which could be considered as small farm size. On an average, the respondents owned highest proportion of cultivable land (63.2%).

Costs and Returns of Aromatic Rice Production

Gross cost was calculated by adding all costs incurred for variable inputs and fixed inputs. On the basis of gross cost per hectare, production costs for Kalijira, Tulsimala and BRRI dhan 34 rice were estimated at Tk. 50280.1, Tk. 48669.8 and Tk. 54948.6, respectively. Thus, the average total costs for aromatic rice was estimated at Tk. 51299.5 per hectare.

Table 1 : Family Size, Age Distribution and Education Levels of Family Members of Aromatic Rice Growers

Particulars	Male		Female		Total	
	No.	%	No.	%	No.	%
			Age group			
0-14	30	19.3	45	33.1	75	25.6
15-64	122	78.2	85	62.5	207	70.9
Above 64	4	2.5	6	4.4	10	3.5
Total	156	100.0	136	100.0	292	100.0
Average	2.6		2.3		4.9	
			Literacy level			
Illiterate	12	8.8	17	13.2	29	10.9
Primary	25	18.4	34	26.4	59	22.3
Secondary	46	33.8	62	48.1	108	40.8
Higher secondary	29	21.4	15	11.6	44	16.6
Graduation and above	24	17.6	1	0.7	25	9.4
Total	136	100.0	129	100.0	265	100.0

Source: *Field survey, 2013.*

Table 2 : Average Land Holdings of Aromatic Rice Growers According to Utilization Pattern

Types of land	Aromatic rice	
	Area (ha)	Percentage
Homestead area	0.09	9.5
Area under pond	0.03	3.2
Owned cultivable land	0.6	63.2
Area under aromatic rice	0.1	10.5
Leased/Mortgaged-in	0.05	5.3
Leased/Mortgaged out	-	-
Shared-in	0.09	9.5
Shared-out	0.01	1.0
Total cultivated land	0.95	100.0

Source: *Field survey, 2013.*

Per hectare gross returns were calculated by multiplying the total amount of product and by-product with their respective farm gate prices. The average per hectare gross return of Kalijira, Tulsimala and BRRI dhan 34 rice were Tk. 80979.5, Tk. 77453.4 and Tk. 89566.4, respectively. Thus, the average per hectare gross return of aromatic rice was Tk. 82666.4.

Benefit cost ratio (BCR) was calculated by dividing gross return by gross cost (Table 3). BCR (undiscounted) of Kalijira, Tulsimala and BRRI dhan 34 rice production emerged as 1.61, 1.59 and 1.63, respectively, implying that Tk. 1.61, Tk. 1.59 and Tk. 1.63 would be earned by investing every Tk. 1.00 in Kalijira, Tulsimala and BRRI dhan 34 rice production.

Table 3 : Production Cost and Returns of Aromatic Rice Production

Items	Varieties (Tk./ha)			Average (Tk./ha)
	Kalijira	Tulsimala	BRRI dhan 34	
A. Gross return	80979.5	77453.4	89566.4	82666.4
Variable cost				
Human labor	25786.7	25983.7	27528.0	26432.8
Power tiller	6269.6	6414.2	6269.3	6317.7
Seed	1432.0	1412.0	1436.0	1426.7
Irrigation	6753.1	5366.9	7572.3	6564.1
Fertilizer				
Urea	2710.0	2578.0	2846.0	2711.3
TSP	574.2	387.2	1632.4	864.6
MP	229.5	193.5	978.0	467.0
Insecticides	605.4	595.9	636.7	612.5
B. Total variable cost	44360.5	42931.4	48898.7	45396.9
Fixed cost				
Interest on operating cost	878.4	847.2	958.7	894.8
Land use cost	5041.2	4891.2	5091.2	5007.9
C. Total fixed cost	5919.6	5738.4	6049.9	5902.6
D. Gross cost(B+C)	50280.1	48669.8	54948.6	51299.5
E. Gross margin(A-B)	36619.0	34522.0	40667.7	37269.6
F. Net return(A-D)	30699.4	28783.6	34617.8	31366.9
G. Benefit cost ratio (A/D) (undiscounted)	1.61	1.59	1.63	1.61

Source: *Field survey, 2013.*

If farmers replace non-aromatic rice with aromatic rice they can obtain additional Tk. 11787.0 from the same one hectare of land (Table 4). It is likely that the positive impact of aromatic rice production on farm household's income is significant. So, it is evident from the partial budget analysis that farmers that produce aromatic rice are more profitable than those that produce non-aromatic rice.

Table 4 : Partial Budget Analysis for the Replacement of Per Hectare Non-Aromatic Rice with Aromatic Rice

Items	Debit (Tk.)	Items	Credit(Tk.)
Additional cost for aromatic rice cultivation	51299.5	Additional revenue for aromatic rice cultivation	82666.4
Revenue forgone for not producing non aromatic rice	83126.0	Cost saved for not cultivating non aromatic rice	63546.1
A. Total	134425.5	B. Total	146212.5
Net change in profit = (B-A) =11787.0			

Source: *Authors' calculation based on field survey, 2013.*

Functional Analysis

Production function analysis was carried out to explore the productivity of the individual inputs (Table 5). To determine the effect of the variable inputs, Cobb-Douglas form of production function was estimated for aromatic rice production. Six independent variables namely, human labor, seed, power tiller, fertilizer, irrigation and insecticides were selected to explain the production of aromatic rice. The regression result shows that the estimated values of the relevant coefficients among the included variables human labor, seed, fertilizer, power tiller and irrigation had significant impact and insecticides had insignificant impact on the per hectare output aromatic rice production**.**

The value of coefficient of determination, R^2, is 0.663 for aromatic rice production, which means that the explanatory variables included in the model explained 66.3 percent of the aromatic rice production. Return to scale for aromatic rice (0.760) is less than unity. It implies that aromatic rice growers are operating in decreasing return to scale.

Resource Use Efficiency

Table 6 reveals the ratios of marginal value product (MVP) and marginal factor cost (MFC) for aromatic rice production. The ratios of MVP and MFC of seed, power tiller, fertilizer and irrigation were greater than unity indicating that there was scope for more use of the inputs to increase the profit. The ratio of MVP and MFC of human labor was less than one but positive, which indicated that farmers

Table 5 : Estimated Values of Coefficient and Related Statistics of Cobb-Douglas Production Function of Aromatic Rice Production

Explanatory variable	Estimated coefficients	Standard errors	t-value
Intercept	4.521	0.808	5.594
Human labor cost(X_1)	0.138**	0.060	2.311
Seed cost (X_2)	0.106**	0.057	1.859
Power tiller cost (X_3)	0.132*	0.077	1.714
Fertilizer cost (X_4)	0.120***	0.035	3.410
Irrigation cost (X_5)	0.277***	0.049	5.678
Insceticide cost (X_6)	-0.019	0.035	-0.548
R^2		0.663	
F-value		17.410	
Return to scale		0.760	

Source: *Authors' estimation, 2013.*
*Note: *** Significant at 1 percent level; ** Significant at 5 percent level; and *Significant at 10 percent level.*

should limit the use of these inputs. The ratio of MVP and MFC of insecticides was negative, which indicated that farmers might have made excessive use of these inputs.

Table 6 : Ratio of Marginal Value Products (MVPs) and Marginal Factor Costs (MFCs) of Different Inputs Incurred in the Production Function of Aromatic Rice

Inputs	Geometric Mean	Coefficient	MVP_{xi}	MFC_{xi}	MVP/MFC
Return	87073.48				
Human labor cost	18586.10	0.138	0.64	1	0.64
Seed cost	1361.00	0.106	6.78	1	6.78
Power tiller cost	6307.95	0.132	1.82	1	1.82
Fertilizer cost	4095.89	0.120	2.55	1	2.55
Irrigation cost	10609.01	0.277	2.27	1	2.27
Insceticide cost	543.03	-0.019	-3.05	1	-3.05

Source: *Author's calculation, 2013.*

Livelihood Pattern of Aromatic Rice Growers

Income Level and Sources of Income

The annual gross income of the sample households was estimated by adding the earnings from all income generating activities of the households during the reference year, 2012. It is evident from Table 7 that average annual income of aromatic rice farmers was Tk. 177606.6. It can be concluded that sampled farmers generated more than one-third of their income from crop farming.

Table 7 : Average Annual Income of Aromatic Rice Growers

	Aromatic rice	
Sources of Income	Value (Tk.)	Percent (%)
A. Farm Income		
Crop	61766.7	34.8
Fisheries	10183.3	5.7
Homestead	3518.3	2.0
Livestock	442746.7	24.1
B. Off-farm Income		
Service	36650.0	20.6
Business	17583.3	9.9
C. Others	5158.3	2.9
Total (A+B+C)	177606.6	100.0

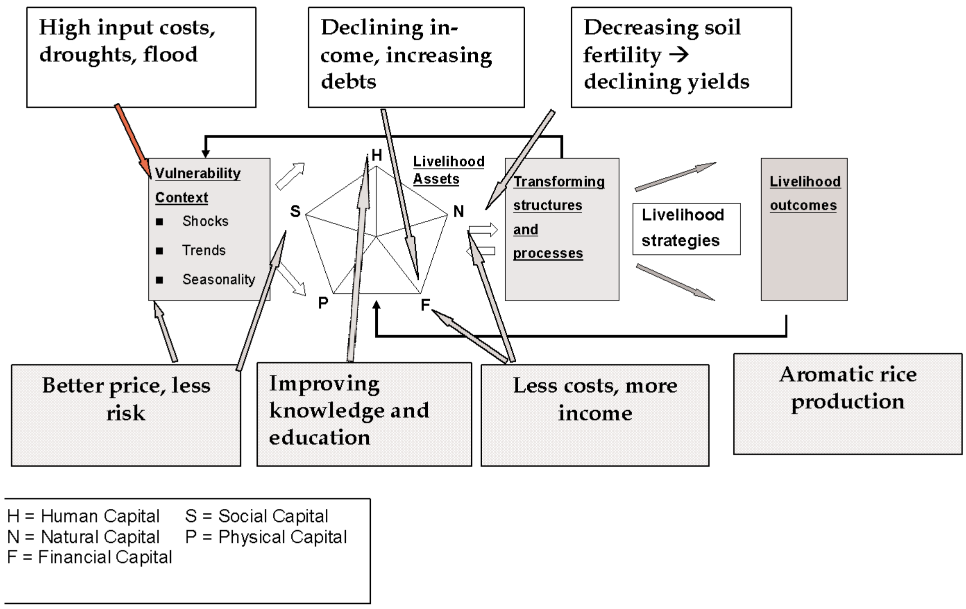
Source: *Field survey, 2013.*

Sustainable Livelihood Framework

The sustainable livelihood framework includes the asset pentagon, which is composed of five types of capital namely human capital, social capital, natural capital, physical capital and financial capital (DFID, 1999). Changes in the asset position during one year are discussed as the transformation and improvement of the livelihood of the farmers.

The framework, which is presented in schematic form below, has been developed to help understand and analyze the livelihoods of the aromatic rice farmers. The asset pentagon lies at the core of the livelihood framework, 'within' the vulnerability context. The pentagon was developed to enable information about people assets to be presented visually, thereby bringing to life important inter-relationships between the various assets. An increase in the natural capital may increase the income and revenue (i. e. financial capital) by means of selling products, which in turn improve the purchasing power and standard of living (i. e., social and physical capital). Health status is directly related to income/food security (with relevant knowledge). Assets are both destroyed and created as a result of the trends, shocks and seasonality of the vulnerability context. Livelihood outcomes are the achievements or outputs of livelihood strategies (DFID, 2001).

Flow Chart 1: The Sustainable Livelihood Framework



Source: *Adapted from DFID, 2001.*

Majority of the farmers reported that quality of the components of human capital has increased over the periods through gaining education and knowledge, improving health condition, more access to nation, better training and development of skill in all the selected areas. Almost all farmers' involvements in different social groups, their managerial capacity through aromatic rice production had improved in the study areas.

Farmers' income had increased and they were able to have more cash savings and liquid assets through production of aromatic rice along with crop farming, livestock rearing, and fisheries. The condition of other major components of housing as well as safe sanitation such as drinking water and paka toilet also developed considerably.

Table 8 : Changes in Human Capital, Social Capital, Natural capital, Financial Capital and Physical Capital of Farm Household

Asset category	Increase	Decrease	Constant
	Human capital		
Health	73.3	11.7	15.0
Education	85.0	3.3	11.7
Knowledge/Efficiency	10.0	3.3	86.7
Access to information	78.3	5.0	16.7
	Social capital		
Involved in social group	23.3	5.0	71.7
Political involvement	11.7	10.0	78.3
Self managerial capability	51.7	1.7	46.6
Social access	53.3	3.3	43.4
	Natural capital		
Cultivable land	31.7	11.7	56.6
Using open water resources	23.3	16.7	60.00
Forests	-	-	100.0
	Financial capital		
Cash in hand	91.7	-	8.3
Cash at bank	46.7	25.0	28.3
Remittance	-	-	100.0
	Physical capital		
Building	11.7	3.3	81.6
Tin roof	33.3	6.7	50.0
Tube well	8.3	5.0	86.7
Paka toilet	26.7	-	73.3
Kacha toilet	73.3	-	26.7
Electric fan	78.3	-	21.7
Bicycle/Motorcycle	28.3	5.0	66.7
Radio/TV	25.0	8.3	66.7
Mobile phone	73.3	1.7	25.0
Fridge	10.0	1.7	88.3
Shop	25.0	3.3	71.7

Source: *Field survey, 2013.*

Problems Faced By the Farmers and Their Probable Solutions

Aromatic rice farmers have been facing some major problems. Sample farmers were asked by the researcher to report major problems and provide their suggestions regarding probable solutions to those problems.

Table 9 : Problems Faced By the Farmers and Their Probable Solutions for the Production of Aromatic Rice

Items	No. of respondents	Percentage (%)
Problem faced by farmers		
Lack of capital	26	43.3
Lack of quality seed	14	23.3
Seed collection problem	21	35.0
High wage rate	39	65.0
High price of fertilizer	29	48.3
Lack of rainfall	11	18.3
Lodging of rice plants	15	25.0
Problem of insect attack	20	33.3
Low price of product	27	45.0
Low Production	38	63.3
Lack of extension service	17	28.3
Storage problem	8	13.3
Probable suggestions		
To ensure easy provision of loans from the financial institutions	24	40.0
To supply the good quality seed	34	56.7
To provide modern technology	30	50.0
To provide subsidy on fertilizer from the government	20	33.3
To fix up the proper price of product by the government	25	41.7
To promote extension services	16	26.7
To improve the production system of crop	18	30.0
To find out the causes of low crop production by sufficient research works	15	25.0
To build up sufficient storage for preserving rice	12	20.0
To provide training facilities	10	16.7
To improve marketing facilities	20	33.3

Source: *Field survey, 2013.*

Note: Percentage has been done based on sample size.

Conclusion and Policy Recommendations

Aromatic rice is a profitable farming venture for farmers and a good source of livelihood. From the study, it was evident that farmers who produce aromatic rice are more profitable than those who produce non-aromatic rice. The regression coefficients among the included variables, human labor, seed, fertilizer, power tiller and irrigation were positive and statistically significant except insecticides cost. The findings revealed that households producing aromatic rice have higher income and better livelihood status.

The following recommendations are made on the basis of the present study:

- Government and non-government research institutes should strengthen their human resources for rice research and seed production;
- Pure seed should be supplied at reasonable price;
- The price of fertilizer and pesticides should be regulated strictly by the government;
- In order to improve profitability of the aromatic rice production, measures are essential to reduce the cost of production;
- Research work should be strengthened to address the issues of low yield; and
- Government may provide short term training programs for better management practices of aromatic rice production.

References

1. Anik 2003: "Economic and Financial Profitability of Aromatic and Fine Rice Production in Bangladesh". MS Thesis, Submitted to the Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh.
2. Ashrafuzzaman M, Islam MR, Shahidullah SM and Hanafi MM 2009: "Evaluation of six aromatic rice varieties for yield and yield contributing characters". *International Journal Agriculture and Biol*ogy, 11, 616–620.
3. BBS 2011: *Statistical Year Book of Bangladesh*, Bangladesh Bureau of Statistics, Ministry in Planning, Government of the Peoples Republic of Bangladesh, Dhaka.
4. BER 2012: *Bangladesh Economic Review*, Economic Advisers Wing, Finance Division, Ministry of Finance, Government of Peoples Republic of Bangladesh, Dhaka.
5. Das C 2000: "A Comparative economic analysis of HYV BR-29 and Hybrid Alock paddy in Kalihati Upazila of Tangail District". MS Thesis, Submitted to the Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh
6. DFID 2001: *Northwest Fisheries Extension Project-2, Livelihood Review. Livelihood Assessment of Communities and Households and Technical Assistance of Aquaculture Technologies and Methods,* Vol.:1, Department for International Development, Dhaka.
7. HIES 2010: *Report on household Income and Expenditure Survey*, Bureau of Statistics Division, ministry of Planning, Government of Peoples Republic of Bangladesh, Dhaka.
8. Raha, SK 2006: "Production and Marketing of Aromatic Rice in Selected Areas of Mymensingh District". MS Thesis. Submitted to the Department of Agribusiness and Marketing Bangladesh Agricultural University, Mymensingh.
9. Sarkar SH and Biswas SC 2002: Report on Sustainability *Through Integrated Farming Approach, Published in The Daily Observer.*

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 061-077
Bangladesh Economic Association
(ISSN 2227-3182)

Commercial Bean Farming under Different Farm Categories and its Impacts on Livelihoods of Farmers in Ishwardi Upazila of Pabna District

MD. RUHUL AMIN*
TOFAZZAL HOSSAIN MIAH**

Abstract *The study was designed to evaluate the profitability of commercial bean farming and its impact on livelihood improvement of the small, medium and large farmers in Ishwardi Upazila of Pabna District. Data were collected from stratified randomly selected 60 commercial bean farmers from three villages of Ishwardi Upazila. The evaluation shows that commercial bean farming is highly profitable for small, medium and large farmers and observes positive impact on livelihood improvement of all categories of farmers. Per hectare net return (profit) from commercial bean farming for small, medium, large and all sampled farmers were Tk 356077, Tk 347403, Tk 343156 and Tk 351007, respectively. It was also found that all kinds of livelihood assets of the selected farmers increased significantly through commercial bean farming. The availability of high quality HYV seeds, affordable labour saving technology and extension services are required to sustain commercial bean farming. It is also suggested that, apart from local and national market, positive steps should be taken to explore export markets so that the farmers can have more benefits from commercial bean farming. A fair price of bean for farmers can be ensured for improving livelihood status of all categories of farmers.*

---

* The author is Scientific Officer (Economics), Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka.

The article is based on Master thesis submitted to the Department of Agricultural Economics, BAU, Mymensingh.

** The author is Professor in the Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh 2202.

1. Introduction

Agriculture is the recognized driving force of the economy of Bangladesh. It has an area of 1,47,570 square kilometers (km^2) and a population of nearly 152.90 million with the density of about 964 person per km^2. The population growth rate is 1.34 percent per annum. Per capita income is about US $1520 and people have a life expectancy of 69 years (BER 2012). There is no alternative to developing the agriculture sector for alleviation of poverty by attaining accelerated economic growth, since the provision of food security, improvement of living standard and employment opportunity of the huge population of the country are directly linked to the development of agriculture. Now-a-days, food security is the burning question in Bangladesh. Vegetables are highly nutritious food and commercial production of vegetables can play an important role to meet the extra demand for vegetables and food security.

At present, total rice cropped area is 78.83 percent. The remainder 21.17 percent of the total cropped area is occupied by other non-rice crops, which include vegetables, wheat, sugarcane, cotton, spices and condiments (BBS 2011). Monoculture of rice for prolonged periods has led to a number of serious physical and biological problems. Continuous rice cultivation has also nutritional impact. Rice monoculture dominates the cropping system in Bangladesh. Consequently, a large percentage of people of Bangladesh are suffering from severe malnutrition. If enough vegetables are not provided to the people, they will suffer from nutritional deficiency to a great extent. According to dieticians, daily requirement of vegetables is 75 - 125 gm of green leafy vegetables, 85 gm of other vegetables, and 85 gm of roots and tubers with other food. Because of increased health consciousness, the well off people of Bangladesh now prefer to take more vegetables than what they consumed in the past. Because of favorable climatic condition and soil, a good number of vegetables are grown round the year. There is a great need for vegetable cultivation in view of the increase in income and employment of the people. Commercial production of vegetables is getting momentum and small, medium and large farmers with proper technical knowledge and skill are increasingly coming forward to undertake this venture. The production of vegetables has therefore been gradually increasing in Bangladesh. In 2010/11, the highest 101516 thousand tonnes of vegetables were produced in the country (BBS 2011).

Beans are important vegetables of world agriculture and are an essential part of a balanced diet in many countries. Bean has been used throughout the world for thousands of years. They come in hundreds of shapes, sizes and colors, are versatile and amazingly convenient because they can be dried and stored for years. Bean is the perfect food for a fat-restricted diet. It contains no cholesterol, and they can help lower your cholesterol level because they are one of the richest sources of fiber. Bean contains at least 20 percent protein and is high in carbohydrate, which provides long lasting energy. Adding bean to daily meals ensures total nutrition, and with wide selection of beans one should be able to find the right flavor for oneself.

Commercial bean production is gaining continuous popularity and recognition by the farm households because of the impact of increased production of crops on socioeconomic upliftment of the producers. In 2010/11 total bean producing area was 17311.74 hectare and 94756 tonnes of bean was produced (BBS 2011). Commercial bean farming is getting importance as a way of investing lesser amount of capital but earning maximum income with more participation of women in production activities. The study has therefore been designed to assess the profitability of commercial bean farming and its impact on livelihood improvement of the farmers, to identify problems associated with bean farming, and formulate appropriate policy strategies for popularizing bean production as an alternative source of income for majority people of Bangladesh.

2. Research Methods

Data Source

For easy accessibility, time and resources constraints, Ishwardi Upazila of Pabna District was selected purposively for data collection. It may be noted here that commercial bean farming is very popular among the farmers in this Upazila. In fact, three villages namely, Betbaria, Muladuli and Shekhpara of Ishwardi Upazila were selected for conducting the field survey, since these villages were famous for commercial bean farming. Here a reasonable size of sample was taken into account to satisfy the objectives of the study. Primary data on commercial bean farming was collected from 60 farmers by using face to face interview from three different villages with the head of each sample household. Secondary data were gathered from different handouts, research reports and various publications to fulfill the objectives of the study. A stratified random sampling technique was followed in the study. Stratification was done on the basis of category of farm size. Here 25 small and 20 medium farmers were taken considering approximately 15.00 percent from two categories of farmers and 15 large farmers were taken purposively because of the number of large farmers were very few. Then almost equal numbers of farmers were taken from each village in each category of farmers.

Analytical Technique

Data was analyzed by using activity budgets, descriptive statistics and frequency distribution tables. Activity budget and descriptive statistics such as mean, median, percent were used to analyze the profitability of commercial bean farming. Frequency distribution tables and percent were used to analyze the impact of commercial bean farming on livelihoods of selected farmers before and after situation.

Gross return: Gross return was calculated by multiplying the total volume of output of an enterprise by the average price in the harvesting period (Dillon and Hardaker, 1993). It consisted of the sum of the volume of main product and by-product. The following equation was used to calculate gross return.

$$GR = Q_m P_m$$

Where:

GR = Gorss return form bean (Tk/ha);

Q_m = Quantity of bean (kg/ha);

P_m = Average price of bean (Tk/kg); and

Net return: Per hectare net return was determined by subtracting per hectare total cost (variable cost and fixed cost) of production from per hectare total return.

To determine the net return of commercial bean production, the following

$$\pi = GR - \sum_{i=1} (P_{xi} X_i) - TFC$$

equation was used in the present study.

Where:

= Net return (Tk/ha);

GR = Gross return from bean (Tk/ha);

P_{xi} = Per unit price of i^{th} inputs used for producing commercial bean (Tk)

X_i = Quantity of the i^{th} inputs used for producing per hectare commercial bean (kg)

TFC = Total fixed cost involved in producing commercial bean (Tk); and

i = 1, 2, 3…... n (number of inputs)

3. Results and Discussion

Profitability of Commercial Bean Farming

Unless otherwise indicated, we assume that farmers purchase inputs and sell output (i.e., bean) in perfectly competitive market. It is also assumed that farmers want to maximize net returns or profits from variable inputs since emphasis is given in this study on commercial bean production. Total gross returns minus gross costs give profit (or net return).

Major Costs of Commercial Bean Farming

The major costs involved in producing commercial bean of all categories of farmers are shown in Table 1. The costs of hired labour per hectare in producing the commercial bean in cases of small, medium, large and all sampled farmers were Tk 34000, Tk 88000, Tk 125000 and Tk 82500, respectively which were 16.03, 38.96, 53.94 and 37.31 percent of total gross costs of production. The costs of family supplied labour in cases of small, medium, large and all sampled farmers were Tk 100000, Tk 52000 Tk 17500 and Tk 56500, respectively, which were 47.15, 23.02, 7.55 and 25.55 percent of total gross costs of production. This indicates that large farmers supplied only a negligible number of family labour (i.e., 7.55 percent) for producing commercial bean. Nevertheless, Table 1 clearly shows that all categories of farmers had to spend the highest amount of money as human labour costs for commercial bean farming.

The insecticide was also a very important input for bean producing farmers and it became the second highest variable cost in commercial bean farming. The average costs of insecticides per hectare for small, medium, large and all sampled farmers were Tk 33710, Tk 40333, Tk 41072 and Tk 38372, respectively, which were 15.89, 17.86, 17.72 and 17.35 percent of total gross costs of production (Table 1). The cost of fencing items and *Matcha* was another important cost item. The average per hectare costs of fencing items and *Matcha* in producing commercial bean for small, medium, large and all sampled farmers were Tk 8856, Tk 11072, Tk 8253 and Tk 7168, respectively, which shared 4.18, 4.90, 3.56 and 3.24 percent of total gross costs of production. The average costs of seeds were Tk 10346, Tk 7560, Tk 7290 and Tk 8400 for small, medium, large and all sampled farmers, respectively, which shared 4.88, 3.35, 3.15 and 3.80 percent of total gross costs of bean production (Table 1).

The total gross costs per hectare for small, medium, large and all sampled farmers in producing commercial bean were Tk 212110, Tk 225892, Tk 231757 and Tk 221125, respectively (Table 1). Per hectare gross cost was the highest for large farmers and the lowest for small farmers. It is evident from the study that large farmers spent relatively more amounts for human labour in producing per hectare commercial bean in comparison with other categories of farmers. The small farmers themselves were involved in commercial bean farming. As a consequence, farm management was the most efficient and per hectare costs were the lowest for small farmers.

Gross Returns from Bean Farming

Yield per hectare of commercial bean for small, medium, large and all sampled farmers were 31566 kg, 31850 kg, 31940 kg and 31785 kg, respectively. Per hectare gross return for small, medium, large and all sampled farmers were Tk 568187, Tk 573295, Tk 574914 and Tk 572132, respectively (Table 1). Both the yield and gross return were the highest for large farmers and lowest for small farmers.

Net Returns of Bean Farming

The net return of per hectare commercial bean farming for small, medium, large and all sampled farmers were Tk 356077, Tk 347403, Tk 343156 and Tk 351007, respectively (Table 1). Small farmers earned the highest amount of net return than those of the medium and large farmers because they spent more time, supervised farm activities more intensively and efficiently. On the other hand, large farmers have had very little time to spare for managing bean farming efficiently. As a result, they had to spend relatively higher amount of cost for human labour in per hectare bean production.

Comparative Profitability of Small, Medium and Large Farmers

The summary result of per hectare gross return, gross cost and net return for small, medium, large and all sampled farmers are presented in Figure 1 (also in Table 1). Gross return per hectare was the highest for large farmers and lowest for small farmers and average gross return for all sampled farmers was Tk 572132. Gross cost was relatively higher for large farmers and lower for small farmers and average gross costs for all sampled farmers was Tk 221125. Per hectare net return was the highest for small farmers and the lowest for large farmers and average net return for all sampled farmers was Tk 351007 (Figure 1 and Table 1).

Small farmers, as stated before, spent more time, supervised farm activities more intensively and efficiently. On the other hand, large farmers had very little time to manage and supervise bean farming activities. For that reason gross cost of per hectare bean production was relatively higher and net return was lower for large farmers.

Table 1 : Per Hectare Profitability of Commercial Bean Production of Small, Medium, Large and All Farmers of the Study Area

Items	Return/cost of bean farmers (Tk/ha)			
	Small	Medium	Large	All
A. Gross Returns				
Main product	568187.0	573295.0	574914.0	572132.0
(bean)	(100.0)	(100.0)	(100.0)	(100.0)
Total	568187.0	573295.0	574914.0	572132.0
	(100.0)	(100.0)	(100.0)	(100.0)
B. Gross Costs				
Power tiller	3200.00	3200.0	3200.0	3200.0
	(1.51)	(1.42)	(1.38)	(1.45)
Seeds	10346.0	7560.0	7290.0	8400.0
	(4.88)	(3.35)	(3.15)	(3.80)
Hired labour	34000.0	88000.0	125000.0	82500.0
	(16.03)	(38.96)	(53.94)	(37.31)
Family labour	100000.0	52000.0	17500.0	56500.0
	(47.15)	(23.02)	(7.55)	(25.55)
Urea	3592.0	3347.0	4404.0	3781.0
	(1.69)	(1.48)	(1.90)	(1.71)
TSP	4575.0	5024.0	5846.0	5141.0
	(2.16)	(2.22)	(2.52)	(2.33)
MOP	1252.0	1535.0	1491.0	1426.0
	(0.59)	(0.68)	(0.64)	(0.64)
Gypsum	356.0	301.0	468.0	372.0
	(0.17)	(0.13)	(0.20)	(0.17)
Borax	1078.0	1632.0	1722.0	1478.0
	(0.52)	(0.72)	(0.74)	(0.67)
Manure	1733.0	2019.0	2097.0	1949.0
	(0.82)	(0.89)	(0.90)	(0.88)
Water charge	3233.0	3289.0	6664.0	4395.0
	(1.52)	(1.46)	(2.88)	(1.99)
Insecticides	33710.0	40334.0	41072.0	38373.0
	(15.89)	(17.86)	(17.72)	(17.35)
Fencing cost	8856.0	11072.0	8253.0	7169.0
	(4.18)	(4.90)	(3.56)	(3.24)
Interest on operating	6178.0	6579.0	6750.0	6441.0
capital	(2.91)	(2.91)	(2.91)	(2.91)
Total	212110.0	225892.0	231757.0	221125.0
	(100.0)	(100.0)	(100.0)	(100.0)
C. Net Return (A-B)	356077.0	347403.0	343156.0	351007.0

Source: *Adapted from Amin (2013).*

Note: Figures in parentheses indicate percentages of total gross return/gross costs.

4. Impacts of Bean Farming on Livelihoods

Livelihood assets

"A livelihood comprises the capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base" (DFID 2000). A livelihood is the set of capabilities, assets, and activities that furnish the means for people to meet their basic needs and support their well being. Therefore the SLF (Sustainable Livelihood Framework) identifies five types of assets or capitals upon which livelihoods are built, namely human capital, social capital, natural capital, physical capital and financial capital.

Figure 1 Comparative Profitability of Small, Medium, Large and All Sampled Farmers

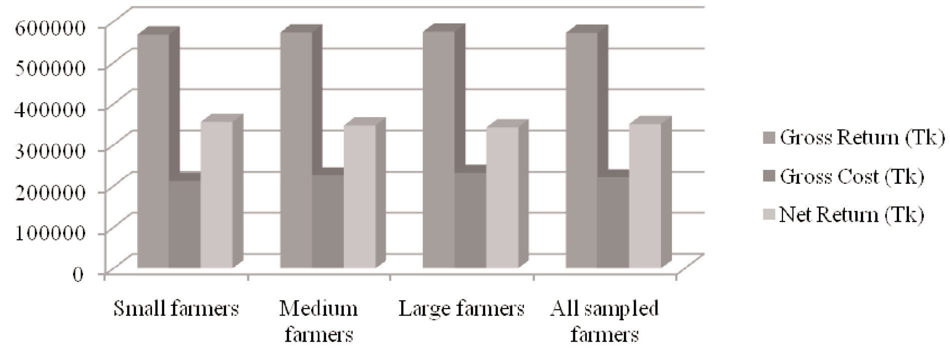


Table 2 shows the improvement of livelihood assets of all categories of selected farmers. Human capital increased 66.40, 65.00, 54.67 and 63.00 percent for small, medium, large and all sampled farmers, respectively. Social capital improvement in the case of small, medium, large and all sampled farmers were 63.33, 66.67, 57.78 and 63.06 percent, respectively. Physical capital increased 43.00, 40.63, 41.67 and 42.50 percent in the case of small, medium, large and all sampled farmers, respectively. Natural capital increased 42.00, 22.22, 15.00 and 28.00 percent in the case of small, medium, large and all sampled farmers, respectively. The corresponding increases in financial capital for small, medium, large and all sampled farmers were 52.00, 61.67, 62.22 and 57.78 percent. Table 2 also reveals that all kinds of livelihood assets for 53.37, 51.24, 46.27 and 50.86 percent of small, medium, large and all sampled farmers, respectively, increased due to commercial bean cultivation in Ishwardi Upazila of Pabna District.

5. Problems of Commercial Bean Farming

Multiple problems are faced by individual farmers in conducting commercial bean farming. All these problems are summarized and presented in Table 3. It is evident from the study that commercial bean farming was a bit expensive for all

Table 2 : Improvement of Livelihood Assets

(All are in percentage of respondents' number)

Livelihood assets	Small farmer	Medium farmer	Large	All sampled
Human capital	66.40	65.00	54.67	63.00
Social capital	63.33	66.67	57.78	63.06
Physical capital	43.00	40.63	41.67	42.50
Natural capital	42.00	22.22	15.00	28.00
Financial capital	52.00	61.67	62.22	57.78
Overall	53.37	51.24	46.27	50.86

Source: *Adapted from Appendix Tables 1, 2, 3, 4 and 5.*

categories of farmers. The selected farmers were economically not quite capable of investing the required amount for producing commercial bean due to shortage of financial capital. Farmers generally complained of inadequate supply of institutional credit in the study area. Since commercial bean farming is a new technique of production for them, they have had insufficient knowledge on scientific method of the bean cultivation. Table 3 shows that on an average 85.0 percent of respondents complained of this problem. At the beginning of the crop season per unit price of bean was quite attractive, but this price varied from one week to another during the whole production period. The volatile price of the bean is, therefore, one of the biggest problems for local commercial farmers. In fact, 83.33 percent of farmers reported about this problem. Shortage of human labour and high wage rate were also some common problems and constraints faced by the farmers in the study area. Lack of good transportation system is another knotty problem for bean growers. If these facilities could be improved the commercial producers could have earned a much higher price from bean farming.

6. Policy Recommendations and Conclusion

Bean production is a highly profitable enterprise and it can generate income earnings and employment opportunity to the rural people of Bangladesh. Some policy recommendations based on the findings and conclusions of the study are presented below:

Table 3 : Major Problems Faced by Commercial Bean Producers

Nature of problem	Percentages of respondent farmers Small	Medium	Large	All
Lack of financial capital	76.00	55.00	26.67	56.67
Inadequate institutional credit	88.00	70.00	53.00	73.33
Lack of knowledge about scientific production techniques	92.00	80.00	80.00	85.00
Shortage of human labour	36.00	60.00	80.00	55.00
High wage rate of labour	80.00	75.00	73.33	76.67
High price of insecticides	72.00	65.00	53.33	65.00
Scarcity of HYV seeds	48.00	65.00	53.33	55.00
Volatile price of bean	96.00	85.00	60.00	83.33
Transportation problem	20.00	30.00	33.33	26.67

Source: *Adapted from Amin (2013).*

i. Since commercial bean production is highly profitable, all financial institutions or commercial banks can provide credit at a reasonable rate of interest to the commercial bean producers;

ii. It is evident from the study that farmers have had very little scientific knowledge about commercial bean cultivation, very short duration training on the method of commercial bean farming should be imparted to the interested local farmers by the extension personnel and/or NGO officials for the greater interest of bean farmers and improving overall livelihood status of the farmers;

iii. Labour shortage during the production period of bean and high wage rate of labour is one of the biggest problems for the farmer, because commercial bean farming is highly labour intensive. The concerned scientists may pay immediate attention to this problem and cost-effective labour-saving technology could be developed so that per unit cost of bean production could drastically be reduced. Thus, per hectare profit of commercial bean farmers could be increased substantially;

iv. Since good quality seed plays a significant role on bean yield, both the concerned government and private institutions should ensure availability of good quality HYV of bean seeds at the door steps of farmers at a reasonable per unit price; and

v. Transportation and communication facilities are not quite conductive for the most efficient marketing in the study area. Policy makers must pay immediate attention to solve this problem of commercial bean farmers.

From the major findings of the study, it can be said that commercial bean farming is highly profitable. Socioeconomic wellbeing of commercial bean growers in the study area is amazing, found to be very well and satisfactory. It can, therefore, be concluded that production of commercial bean is profitable and helpful for improving the livelihood status of all categories of farmers. A considerable scope apparently exists to increase the productivity of commercial bean, therefore income, employment, nutritional status and overall livelihood status of farmers in the study area as well as other potential areas of Bangladesh. It also helps to ameliorate the problem of gender issue by enabling the women to participate in income generating activities and household decision making process in rural areas. The management practices of commercial bean farming in the study area were not found efficient enough. Farmers have least idea about the application of inputs in right time with right doses, especially about insecticides which is very sensitive for yield and human health as well. Consequently, they used either over or under doses of some inputs. Despite this fact, there is ample scope to increase per hectare yield of this potential crop by introducing scientific methods and high yielding variety. Efficient production and cost-effective management training in light of the observed problems, needs, goals and resource base can lead to viable production practices and sustainable income and therefore livelihood improvement from commercial bean production.

References

1. Amin, M.R. (2013), "Impact of commercial bean farming on livelihood improvement of farmers in Ishwardi Upazila of Pabna district", MS Ag Econ (Production Economics) thesis, Bangladesh Agricultural University, Mymensingh.

2. BBS (2011), Yearbook of Agricultural Statistics of Bangladesh, Bangladesh Bureau of Statistics, Statistical Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.

3. BER (2012), Bangladesh Economic Review, Economic Advisory Section, Department of Finance, Ministry of Finance, Bangladesh.

4. DFID (2000), Sustainable Livelihoods Guidance Sheets. Victoria Street, London, SW1E5JL, UK.

5. Dillon, J.L. and Hardaker, J.B. (1993), Farm Management Research for Small Farmers Development, Food and Agriculture Organization of United Nations, Rome, Italy.

6. Population Census Report (2011), Bangladesh Bureau of Statistics, Statistical Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka.

Appendix Table 1 Changes in Human Capital

(All are in percentage of respondents' number)

Components	Small farmers (25)			Medium farmers (20)			Large farmers (15)			All sampled farmers (60)		
	Increased	Decreased	Unchanged	Increased	Decreased	Unchanged	Increased	Decreased	Unchanged	Increased	Decreased	Unchanged
Health and sanitation	88.00	12.00	0.00	60.00	10.00	30.00	46.67	26.67	26.67	68.33	25.00	16.67
	(22)	(3)	(0)	(12)	(2)	(6)	(7)	(4)	(4)	(41)	(9)	(10)
Education	92.00	0.00	8.00	90.00	0.00	10.00	80.00	0.00	20.00	88.33	0.00	11.67
	(23)	(0)	(2)	(18)	(0)	(2)	(12)	(0)	(3)	(53)	(0)	(7)
Training	20.00	0.00	80.00	25.00	0.00	75.00	20.00	0.00	80.00	21.67	0.00	78.33
	(5)	(0)	(20)	(5)	(0)	(15)	(3)	(0)	(12)	(13)	(0)	(47)
Knowledge/efficiency	72.00	0.00	28.00	65.00	0.00	35.00	73.33	0.00	26.67	70.00	0.00	30.00
	(18)	(0)	(12)	(13)	(0)	(7)	(11)	(0)	(4)	(42)	(0)	(18)
Access to information	60.00	0.00	40.00	85.00	5.00	10.00	53.33	6.67	40.00	66.67	3.33	30.00
	(15)	(0)	(10)	(17)	(1)	(2)	(8)	(1)	(6)	(40)	(2)	(18)

Note: Figure within the parenthesis indicate respondent numbers
Source: Adapted from Amin (2013).

Appendix Table 2 Changes in Social Capital

(All are in percentage of respondents' number)

Components	Small farmers (25)			Medium farmers (20)			Large farmers (15)			All sampled farmers (60)		
	Increased	Decreased	Unchanged	Increased	Decreased	Unchanged	Increased	Decreased	Unchanged	Increased	Decreased	Unchanged
Involved in social	36.00	12.00	52.00	70.00	5.00	25.00	66.67	6.67	26.67	55.00	8.33	36.67
group/activities	(9)	(3)	(13)	(14)	(1)	(5)	(10)	(1)	(4)	(33)	(5)	(22)
Political	24.00	0.00	76.00	45.00	25.00	30.00	40.00	6.67	53.33	35.00	10.00	55.00
involvement	(6)	(0)	(19)	(9)	(5)	(6)	(6)	(1)	(8)	(21)	(6)	(33)
Self-managerial	88.00	12.00	0.00	75.00	0.00)	25.00	66.67	0.00	33.33	78.33	5.00	16.67
capability	(22)	(3)	(0)	(15)	(0)	(5)	(10)	(0)	(5)	(47)	(3)	(10)
Social prestige	80.00	4.00	16.00	55.00	5.00	40.00	33.33	46.67	20.00	60.00	15.00	25.00
	(20)	(1)	(4)	(11)	(1)	(8)	(5)	(7)	(3)	(36)	9	15
Decision making	84.00	8.00	8.00	60.00	5.00	35.00	80.00	0.00	20.00	75.00	5.00	20.00
ability	(21)	(2)	(2)	(12)	(1)	(7)	(12)	(0)	(3)	(45)	(3)	(12)
Women	68.00	0.00	32.00	95.00	0.00	5.00	60.00	0.00	40.00	75.00	0.00	25.00
empowerment	(17)	(0)	(8)	(19)	(0)	(1)	(9)	(0)	(6)	(45)	(0)	(15)

Note: Figures within the parenthesis indicate respondent numbers

Source: Adapted from Amin (2013).

Appendix Table 3 Changes in Physical Capital

(All are in percentage of respondents' number)

Items		Small farmers (25)			Medium farmers (20)			Large farmers (15)			All sampled farmers (60)		
		Increased	Decreased	Unchanged	Increased	Decreased	Unchanged	Increased	Decreased	Unchanged	Increased	Decreased	Unchanged
Housing	Building	20.00	0.00	80.00	30.00	0.00	70.00	40.00	0.00	60.00	28.33	0.00	71.67
		(5)	(0)	(20)	(6)	(0)	(14)	(6)	(0)	(9)	(17)	(0)	(43)
	Tin roof	76.00	8.00	16.00	45.00	0.00	55.00	60.00	6.67	33.33	61.67	5.00	33.33
		(19)	(2)	(4)	(9)	(0)	(11)	(9)	(1)	(5)	(37)	(3)	(20)
Agricultural equipments		0.00	0.00	100.0	25.00	10.00	65.00	33.33	20.00	46.67	16.67	8.33	75.00
		(0)	(0)	(25)	(5)	(2)	(13)	(5)	(3)	(7)	(10)	(5)	(45)
Bicycle/motorcycle/ motor van		68.00	0.00	32.00	40.00	15.00	45.00	46.67	0.00	53.33	53.33	5.00	41.67
		(17)	(0)	(8)	(8)	(3)	(9)	(7)	(0)	(8)	(32)	(3)	(25)
Electricity		48.00	0.00	52.00	35.00	0.00	65.00	13.33	0.00	86.67	35.00	0.00	65.00
		(12)	(0)	(13)	(7)	(0)	(13)	(2)	(0)	(13)	(21)	(0)	(39)
TV/Radio/VCD/ DVD		32.00	0.00	68.00	60.00	0.00	40.00	13.33	0.00	86.66	33.33	0.00	66.67
		(8)	(0)	(17)	(12)	(0)	(8)	(2)	(0)	(13)	(20)	(0)	(40)
Cable network		24.00	0.00	76.00	15.00	0.00	85.00	40.00	0.00	60.00	33.33	0.00	66.67
		(6)	(0)	(19)	(3)	(0)	(17)	(6)	(0)	(9)	(20)	(0)	(40)
Mobile phone		76.00	0.00	24.00	75.00	10.00	15.00	86.67	6.67	6.67	78.33	5.00	16.67
		(19)	(0)	(6)	(15)	(2)	(3)	(13)	(1)	(1)	(47)	(3)	(10)

Note: Figures within the parenthesis indicate respondent numbers

Source: Adapted from Amin (2013).

Appendix Table 4 Changes in Natural Capital

(All are in percentage of respondents' number)

Items	Small farmers (25)			Medium farmers (20)			Large farmers (15)			All sampled farmers (60)		
	Increased	Decreased	Unchanged	Increased	Decreased	Unchanged	Increased	Decreased	Unchanged	Increased	Decreased	U
Cultivable land	40.00	0.00	60.00	30.00	0.00	70.00	40.00	0.00	60.00	36.67	0.00	
(own)	(10)	(0)	(15)	(6)	(0)	(14)	(6)	(0)	(9)	(22)	(0)	
Cultivable land	44.00	0.00	56.00	20.00	0.00	80.00	0.00	0.00	100.00	25.00	0.00	
(leased	(11)	(0)	(14)	(4)	(0)	(16)	(0)	(0)	(15)	(15)	(0)	
Pond	0.00	16.00	84.00	0.00	15.00	85.00	13.33	20.00	66.67	3.33	16.67	
	(0)	(4)	(21)	(0)	(3)	(17)	(2)	(3)	(10)	(2)	(10)	
Tube-well	84.00	0.00	16.00	40.00	0.00	60.00	6.67	0.00	93.33	50.00	0.00	
water access	(21)	(0)	(4)	(8)	(0)	(12)	(1)	(0)	(14)	(30)	(0)	

Note: Figures within the parenthesis indicate respondent numbers
Source: Adapted from Amin (2013).

Appendix Table 5 Changes in Financial Capital

(All are in percentage of respondents' number)

Items	Small farmers (25)			Medium farmers (20)			Large farmers (15)			All sampled farmers (60)		
	Increased	Decreased	Unchanged	Increased	Decreased	Unchanged	Increased	Decreased	Unchanged	Increased	Decreased	Unchanged
Cash in hand	76.00	12.00	12.00	75.00	5.00	20.00	100.00	0.00	0.00	81.67	6.67	11.67
	(19)	(3)	(3)	(15)	(1)	(4)	(15)	(0)	(0)	(49)	(4)	(7)
Savings	40.00	0.00	60.00	45.00	10.00	45.00	40.00	33.33	26.67	41.67	11.67	46.67
	(10)	(0)	(15)	(9)	(2)	(9)	(6)	(5)	(4)	(25)	(7)	(28)
Jewelry	40.00	0.00	60.00	65.00	0.00	35.00	46.67	33.33	20.00	50.00	8.33	41.67
	(10)	(0)	(15)	(13)	(0)	(7)	(7)	(5)	(3)	(30)	(5)	(25)

Note: Figures within the parenthesis indicate respondent numbers
Source: Adapted from Amin (2013).

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 079-091
Bangladesh Economic Association
(ISSN 2227-3182)

Profitability and Resource Use Efficiency of Maize Production in Changing Farming System and Its Implication in Household Food Security

MD. RAIS UDDIN MIAN*
A.M. KUDRAT-E-HUDA**

Abstract *The study was undertaken to investigate the profitability and resource use efficiency of maize production and implication of maize in household food security under changing farming system in Lalmonirhat district of Bangladesh. Sixty farms of different sizes constituted the sample of the study and both descriptive and econometric techniques were used to analyze the collected primary data. The existing farming system experienced major changes though they were not the same for all the sub-systems. Maize is a highly profitable crop irrespective of farm categories and profitability was the highest for small farms followed by large and medium farms. Maize is also a labor intensive technology. Irrigation, manure and credit were the most important variables influencing maize production positively and significantly while seed cost was the negatively influencing variable in this direction. Irrigation, manure and insecticide were found to be the efficiently used resources in production of maize where seed was an overused resource irrespective of farm categories. The respondents also used some resources more than their required amount in order to derive higher profit. Food security was found positively related with farm size while a negative relationship was found between farm size and contribution of maize in household food security. Maize farming brought a positive contribution to household food security in the study area, particularly for smaller farm households who are generally vulnerable in the case of food security.*

* Associate Professor, Department of Agricultural Finance, Bangladesh Agricultural University, Mymensingh
** Executive Officer, Janata Bank Ltd.

1. Introduction

Farming system is a unique arrangement of enterprises that the households manage to achieve a pre-determined goal in accordance with well defined practices (Shaner *et al.,* 1982). Farming system is a dynamic concept and it depends on the ability of farmers, availability of input, market potential of output, etc. Profitability indicates the ability of an enterprise to generate income in excess of cost while the resource use efficiency generally means generating optimum output avoiding both over and under use of scarce resources. Profitability and efficiency are two important things to be considered in a farming system. Maize is the third most important grain crop in the world. It is introduced as relatively a new crop in the cropping patterns of Bangladesh especially in the northern region. It is a versatile crop with genetic variability enabling it to grow successfully throughout the world covering low and tropical, subtropical and temperate agro climatic conditions. Most countries of the Asia pacific region grow maize.

Though maize is relatively a new crop in Bangladesh, it has an enormous market potential. It has multiple uses as every part of the plant is used in one form or the other. Grain can be used for human consumption in various ways, such as, corn meal, fried grain and roasted cob or popped and corn flour; stem and foliage of maize plant can be used as green crop, hay, silage and pasture to feed livestock; stalk and dry leaves covering of cobs and shelled cobs can be used as fuel; etc. (Chowdhury and Islam, 1993). Maize meal provides more calories and vitamin.

Food security is availability of sufficient food of choices of all people at all times along with necessary purchasing power (Ahammed, 2009). To attain food security in Bangladesh, diversification side by side increasing yield and production is essential. As comparatively a new enterprise, maize certainly can play an important role in this diversification. Cultivation of maize has also been contributing significantly to the poverty reduction and achieving economic self-reliance by the poor in recent years in the region, including the vast char areas where large-scale maize farming has become possible. Maize has a great prospect for being established as a popular crop. After rice and wheat, it is a major cereal crop to reduce shortage of food, poultry feed and malnutrition. In terms of protein, carotene and oil content, maize is much better than rice. It is obvious that if rice is partially replaced by maize in the diet, protein intake will be increased. Maize is highly acceptable due to low cost and higher yield than rice and wheat (Huda, 2013).

Northern Bangladesh is a risk prone region of the country and Lalmonirhat district is one of the riskiest areas of this region. But in recent years maize has become one of the popular crops of this area though it is a new crop in the existing farming system. A good number of people, including producers, laborers, traders, etc., are involved directly and indirectly with maize production, processing and marketing. So, maize has certainly an implication for food security of Bangladeshi people in grass roots level. Thus issues like cost, return, profitability, resource use, etc. of maize production need be addressed properly. But studies regarding these are very few. Therefore, this study is expected to provide valuable information that might be useful for formulating appropriate policy for widespread cultivation of maize in the study area and the country as a whole. The maize producers, development organizations and policy are expected to benefit from the study. The present study seeks to achieve the following specific objectives:

a) to identify the major changes in existing farming system in the study area
b) to determine profitability and returns to scale of maize production and contributions of key variables in the production process
c) to study resource use efficiency in maize farming
d) to investigate the implication of maize in household food security of the respondents.

2. Methodology of the Study

Five villages with similar physiographic characteristics of two unions, i.e., Tongvanga and Singimari, of Hatibanda upazila of Lalmonirhat district were the area of the study where maize is an emerging and popular crop. Depending upon farm size, 60 maize producers were randomly selected from the prepared list among which 35 were small, 15 were medium and the rest 10 were large farmers. Primary data were collected following survey method during August to October 2012 and the period of the study was 2011. Both descriptive statistics and econometric method were employed to analyze the collected data as mentioned below.

a. Gross margin was calculated by deducting total variable cost from gross return while net return was the difference between total return and total cost. Again, returns to scale was determined by summing up the regression coefficients, and undiscounted benefit cost-ratio (BCR) was calculated by dividing gross benefit by gross cost.

b. Interest on operating capital (IOC) was calculated by using the following formula (Main and AL-Imran, 2005):
$IOC= AI \times i \times t$
Where, AI= average investment = (total investment)/2, i= rate of interest and t=length of crop period (months).

c. The standard way to examine efficiency of resource allocation is to compare marginal value product (MVP) with the marginal factor cost (MFC) of each variable input. The optimum use of a particular input would be indicated by the condition of equality of MVP and MFC, i.e., MVP/MFC = 1 (Dhawan and Bansal, 1977).

If (MVP/MFC) is greater than 1, the resource is sub-optimally used and the gross return could be increased by using more of the resource. If it is less than 1 the resource is over used and the excess use of resource should be decreased to minimize the loss. The MVPs were computed from the estimated production elasticity by using the following method:

where, b_i= regression coefficient (i=1,2,3,.......,n), X_i=geometric mean of X_i variable and Y=geometric mean of gross return.

The above equation can be written as:
$dY/dX_i=b_{i.}\ Y/X_i$
where, dY/dX_i= slope of the production function.

Hence the MVPs indicate the value product in taka, per taka input cost expresses the ratio of MVP and MFC.

(d) In order to estimate the effects of key variables in the maize production, Cobb-Douglas form of production function (Gujarati, 2003) was used in modified form. The specification of the function was as follows:
$Y_i= aX_1^{b_1} X_2^{b_2}X_3^{b_3}X_4^{b_4} X_5^{b_5}X_6^{b_6}X_7^{b_7} X_8^{b_8}X_9^{b_9}\ e^{\ ui}$
In the log linear form it can be written as:
$InY= lna+b_1lnX_1+b_2lnX_2+b_3lnX_3+b_4lnX_4+b_5lnX_5+ b_6lnX_6+ b_7lnX_7+b_8lnX_8+ b_9 lnX_9+u_i$

where, ln= natural logarithm, Y= return per hectare (Tk), X_1= seed cost (Tk/ha), X_2= human labor cost (Tk/ha), X_3= power tiller cost (Tk/ha), X_4= irrigation cost (Tk/ha), X_5= manure cost (Tk/ha), X_6= fertilizer cost (Tk/ha), X_7= insecticide cost (Tk/ha), X_8= seed rate (Kg/ha), X_9= amount of credit used (Tk/ha), a= intercept, b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8, b_9= production coefficient of the respective input and u_i error term.

e) Food security (FS) was calculated as
FS= (TAF/TRF) × 100
where, TAF= total availability of food and TRF = total requirement of food.
Again the contribution of maize in food security was calculated as CFS= (FS×AFM)/TAF
where, CFS= contribution in food security and AFM = availability of food from maize.

3. Results and Discussion

3.1 Changes in the Existing Farming System

This study was an effort to identify the major changes that took place in the recent past in the existing farming system of the study area. The responses of the maize producers in this direction are summarized in Table 1. Farming system is not a simple collection of plant and animal, rather it is a complicated interwoven mesh of soil, crop, livestock, workers and so on (CGIAR, 1986). It can be divided into several sub-systems like crop, forest, animal, fish, etc. It is evident from Table 1 that the major change in the crop sub-system was occupying acreage by maize and

Table 1 : Major Changes in Existing Farming System

Major sub-system	Major changes
Crop	Maize and cassava are two newly introduced crops with existing major crops rice, jute and wheat. Maize is an emerging crop occupying acreage of other crops. Besides, maize is popular in almost all types of farmers while cassava is popular in marginal and landless farmers only.
Livestock	Number of livestock reduced dramatically due to contraction of grazing land. Some hybrids have been introduced with traditional breeds and beef fattening and milch cow rearing are widely practiced. Lack of pasture is the major constraint for expansion of this sub-system.
Poultry	Several commercial poultry farms have been established near market areas and number of scavenging birds reduced drastically in all categories of households.
Fisheries	Scope of capture fishery reduced to minimum and culture fishery is practiced widely. Traditional breeds are almost in extinction and hybrids and exotics are cultured extensively.
Homestead	Traditional varieties are almost in extinction because of lower productivity and HYVs occupied all households. Number of fruit trees reduced remarkably while the number of forest trees increased.

cassava. Moreover, increase of forest trees in lieu of fruit ones in recent years is worth mentioning in the case of homestead farming. So, it can be said that major changes occurred in all segments of the farming system though they were not the same for all sub-systems in the study area.

3.2 Cost of Maize Farming

Variable and fixed costs of maize production per hectare were estimated and are summarized in Table 2. The table shows that human labor was the largest cost item of maize production irrespective of farm categories in the study area. It was used for land preparation, shelling, harvesting and application of other inputs. Human labor alone constituted 32.64, 45.83 and 45.98 percent of total cost of small, medium and large farms, respectively. The second largest cost item was land use where the respective contributions in total cost are 18.33, 14.37 and 14.58 percent. The third important cost item of maize production in the study area was fertilizer, which contributed 14.23, 11.31 and 10.85 percent of total cost of the farms, respectively. Other cost items were seed, irrigation, power tiller and manure in order of their contribution to total cost. Besides, farmers had to spend some money for purchasing insecticide. They also incurred a commencement cost, i.e., holding some money in hand before starting maize cultivation. The objective of this cost was to have a good and uninterrupted start for smooth operation. Considering all cost items together, variable cost was 78.06, 82.44, and 82.04 percent of total cost for small, medium and large farms, respectively, while the percentage for fixed cost was 21.94, 17.56 and l8.45. Thus, among physical inputs, maize is a labor intensive technology in changing the arming system and it was also mentioned by the respondents during survey. All the cost items bear more or less the same importance to the maize producers. Moreover, the cost of producing maize maintained a positive relationship with farm size in the study area.

3.3 Return and Profitability of Maize Farming

Per hectare gross return of maize production was determined by multiplying yield per hectare by the prevailing price in the local market. Table 3 shows that per hectare gross margin was estimated at Tk 52579.35, 50150.45 and 63611.30 for small, medium and large farms, respectively. The corresponding net return was found to be Tk 43436.35, 40112.65 and 52828.30. Net return as percentage of total cost was the highest for small farm (104.25 percent) followed by large (88.01 percent) and medium (70.16 percent) farms. The undiscounted BCR also showed the same order where the figures are 2.04, 1.88 and 1.70, respectively. In terms of

Table 2 : Per Hectare Cost of Maize Production

Cost items	Small farm (Tk/ha)	Medium farm (Tk/ha)	Large farm (Tk/ha)
A. Variable cost			
labor	13600.00 (32.64)	26200.00 (45.83)	27600.00 (45.98)
Power tiller	2869.00 (6.89)	3121.00 (5.46)	3326.00 (5.54)
Seed	4630.00 (11.11)	5090.00 (8.90)	5455.00 (9.09)
Manure	1830.85 (4.39)	1897.00 (3.32)	1977.50 (3.29)
Fertilizer	5930.00 (14.23)	6463.00 (11.31)	6510.00 (10.85)
Insecticide	460.00 (1.11)	558.00 (0.98)	573.0 (0.95)
Irrigation	3200.00 (7.68)	3800.00 (6.65)	3800.00 (6.33)
Total variable cost	**32520.65 (78.06)**	**47129.55 (82.44)**	**49241.70 (82.04)**
B. Fixed cost			
Interest on operating capital	658.00 (1.58)	725.00 (1.27)	920.00 (1.53)
Land use cost	7635.00 (18.33)	8213.00 (14.37)	8753.00 (14.58)
Commencement cost	850.00 (2.04)	1100.00 (1.92)	1400.00 (2.33)
Total fixed cost	**9143.00 (21.94)**	**10038.00 (17.56)**	**11073.00 (18.45)**
Total cost (A+B)	**41663.65 (100)**	**57167.35 (100)**	**60024.70 (100)**

Figures in parentheses indicate percentage of total cost

both net return (percentage term) and BCR, small farm was the most profitable followed by large and medium farms in the study area. It was found that maize is both labor and capital intensive compared to other crops in the study area. Small farms had the advantage of home supplied labor while the large farms had the advantage of capital to hire labor for timely use. Medium farms lacked these advantages in operation. So, it might be one of the reasons for making higher profit by small and large farms compared to medium ones. But one thing is worth mentioning that maize is a profitable crop irrespective of farm categories and it is a highly profitable crop in the changing farming system of the study area.

Table 3 : Per Hectare Return and Profitability of Maize Production

Particulars		Small farm	Medium farm	Large farm
Yield (kg)		4255.00	4864.00	5239.00
Gross return (Tk)		85100.00	97280.00	112853.00
Total variable cost (Tk)		32520.65	47129.55	49241.70
Total fixed cost (Tk)		9143.00	10038.00	11073.00
Gross/Total cost (Tk)		41663.65	57167.35	60024.70
Gross margin (Tk)		52579.35	50150.45	63611.30
Net return	Tk	43436.35	40112.65	52828.30
	% of total cost	104.25	70.16	88.01
BCR (undiscounted)		2.04	1.70	1.88

3.4 Contributions of Key Variables in Maize Production

The respondents were asked about the most important variables affecting maize production. According to their response, 9 variables were selected for Cobb-Douglas production function analysis and the results are summarized in Table 4. Among the selected variables, regression coefficients of irrigation, manure, insecticide and credit of small farm were positive and significant and in the case of manure and credit, they were highly significant. It means that other factors remaining constant a 1 percent increase in these variables would increase gross return by 0.065, 0.168, 0.137 and 0.348 percent, respectively. In the case of medium farm, significant variables were seed, irrigation, manure, insecticide, seed rate and credit. Again, except seed cost, others had positive coefficient, and coefficients of seed, irrigation and credit were highly significant. It means that a 1 percent increase in seed cost would decrease the gross return by 0.389 percent while the same increase in irrigation, manure, insecticide, seed rate and credit would be able to increase gross margin by 0.193, 0.113, 0.129, 0.306 and 0.427 percent, respectively. Except human labor and power tiller, other variables brought significant impact on gross return of large farms. The coefficients of seed cost, irrigation, manure and seed rate were highly significant and only seed cost had negative sign. It implies that, a 1 percent increase in seed cost would decrease gross return by 0.312 percent while the same increase in irrigation, manure, fertilizer, insecticide, seed rate and credit would increase gross return by 0.123, 0.153, 0.065, 0.044, 0.323 and 0.489 percent, respectively. Values of R^2 show more or less satisfactory fit of the models and highly significant F-values indicate that all the selected variables were important to explain the total variation of maize production. Table 4 also reveals that irrigation, manure and credit were the most important inputs for maize production in the study area as they brought highly significant impact for two of the three farm categories. The summation of all regression coefficients was less than one for all farms. So, the production functions exhibit decreasing returns to scale implying that if all the variables were increased by 1 percent gross return would be increased by 0.541, 0.601 and 0.465 percent for small medium and large farms, respectively. Thus it can be said that farmers are

Table 4 : Estimated Coefficients and Related Statistics of Cobb-Douglas Production Function Model

Explanatory variable	Small farm	Medium farm	Large farm
Intercept	8.624	8.523	9.485
	(0.821)	(1.893)	(0.456)
Seed cost	-0.081	- 0.389***	-0.312***
(X_1)	(0.173)	(0.135)	(0.066)
Human labor cost	0.029	0.172	0.045
(X_2)	(0.081)	(0.165)	(0.062)
Power tiller cost	0.049	-0.048	0.024
(X_3)	(0.052)	(0.082)	(0.045)
Irrigation cost	0.065*	0.193***	0.123***
(X_4)	(0.035)	(0.059)	(0.026)
Manure cost	0.168***	0.113**	0.153***
(X_5)	(0.054)	(0.043)	(0.035)
Fertilizer cost	0.006	0.125	0.065*
(X_6)	(0.127)	(0.197)	(0.060)
Insecticide cost	0.137**	0.129*	0.044*
(X_7)	(0.062)	(0.071)	(0.052)
Seed rate	0.168	0.306*	0.323***
(X_8)	(0.164)	(0.231)	(0.080)
Credit	0.348***	0.427***	0.489**
(X_9)	(0.097)	(0.058)	(0.109)
R^2	0.752	0.538	0.741
F-value	8.669***	5.145***	12.295***
Returns to scale	0.541	0.601	0.465

Figures within parentheses indicate standard errors
***significant at 1% level
**significant at 5% level
*significant at 10% level

using more of some inputs than their required amount just to make higher profit. This unsound practice should be avoided from economic point of view.

3.5 Efficiency in Resource Use in Maize Production

Economic efficiency refers to the combination of inputs that maximize individual or social objectives (Doll and Orazem, 1984). To accomplish the objective of profit maximization i.e., for efficient allocation of resources, one should use more of the variable resource so long as the value of the added product is greater than the cost of the added amount of the resource used in producing it. The estimated

Table 5 : Ratio of MVPs and MFCs o Different Inputs in Maize Production Function

Resource	Small farm			Medium farm			Large farm		
	Geometric mean	Coefficient	MVP_{xi}/MFC_{xi}	Geometric mean	Coefficient	MVP_{xi}/MFC_{xi}	Geometric mean	Coefficient	MVP_{xi}/MFC_{xi}
Seed	3112.32	-0.081	-2.90	5027.98	-0.389	-8.57	3156.65	-0.312	-11.10
Human labor	12659.34	0.029	0.26	11215.36	0.172	1.70	18336.85	0.045	0.27
Power tiller	2536.22	0.049	2.16	3965.48	-0.048	-1.34	3201.36	0.024	0.84
Irrigation	4258.99	0.065	1.70	4236.09	0.193	5.10	4269.49	0.123	3.23
Manure	1236.67	0.168	15.20	1992.28	0.113	6.29	2781.95	0.153	6.17
Fertilizer	5241.69	0.006	0.13	6436.69	0.125	2.15	6025.69	0.065	1.21
Insecticide	527.29	0.137	28.99	684.36	0.129	20.90	729.64	0.044	6.76

MVP of different inputs for maize production is presented in Table 5. If MFC_{xi} divides the MVP_{xi} the product will be equal to the value of MVP_{xi} because MFC at all cases is equal to Tk one (X_i= i^{th} input).

It is evident from Table 5 that irrigation, manure and insecticide are the efficiently used resources for maize production by all farms because they have positive and greater than MVP/MFC ratio irrespective of farm categories. Similarly seed is an inefficiently used resource as it has negative and greater than one MVP/MFC ratio in all farm categories.

3.6 Implication of Maize in Household Food Security

Generally rice and wheat come first to meet the food requirement of Bangladeshi people and the farmers of Bangladesh usually choose cropping pattern emphasizing these two cereals. But in the study area maize is getting popularity in this traditional cropping system. So, it is assumed that maize certainly bears some importance in the food situation of the study area. Therefore, an attempt was made to investigate the implication of maize in food security status of the respondents' households under study.

Respondents consumed several food items in a year and units of these items were also different. Again there are several methods to calculate food security- ranging from easy algebraic to highly mathematical using strict scientific data. In the study area scientific information were not possible to collect from the respondents. So, food security of respondent households was examined by using easily available data like total requirement of food, total availability of food, etc.

Table 6 : Contribution o Maize in Household Food Security

Farm category	TRF (Tk)	TAF (Tk)	FS (%)	Contribution of maize	
				TAM (Tk)	CFS (%)
Small	63875.00	22812.50	35.71	18251.27	28.57
Medium	131400.00	78840.00	60.00	24637.50	18.75
Large	236520.00	223380.00	94.45	35475.90	15.00
All	143931.67	108344.16	63.38	26121.55	15.28

and analysis was done accordingly. As there were differences in food items and in their measurements, all the data were converted into money terms for calculation.

It is evident from Table 6 that yearly average total requirement of food (TRF) for small, medium and large farm households was Tk 63875.00, 131400.00 and 236520.009, respectively. Against this requirement the respective total availability of food (TAF) was Tk 22812.50, 78840.00 and 223380.00. Thus food security (FS) for small, medium and large farm households stood at 35.71, 60.00 and 94.45 percent, respectively. So all of TRF, TAF and FS were positively related with farm size and overall household FS was found to be 63.38 percent. Moreover, larger farm households were more food secured than smaller ones in the study area. In TAF, total availability from maize (TAM) in small farm was Taka 18251.27 while it was Tk 24637.50 for medium farm and Tk 35475.90 for large farm. Thus contribution in food security (CFS) by maize farming stood at 28.57, 18.75 and 15.00 percent for small, medium and large farm, respectively. The overall CFS stood at 15.28 percent and CFS maintained a negative relationship with farm size.

Thus it proves that maize is an important crop enhancing food security status of the respondents irrespective of farm categories in the study area. Moreover, its role is worth mentioning in the case of small farms that are generally vulnerable in the status of food security. So, maize certainly bears a good and favorable implication for enhancing the household food security status of the producers in the study area.

4. Conclusion

Major changes took place in all sub-systems of farming in the study area. Maize is relatively a new crop in the changing farming system. But it is getting popularity because it is comparatively a highly profitable crop irrespective of farm categories in the study area. Small farm realized the largest profit while it was the lowest for medium farm. Maize is also a labor intensive technology and labor cost constituted a remarkable share in total cost of production. Irrigation, manure and credit were the most important factors as they affected maize production positively and significantly in almost all the farms under study. In the case of resource use efficiency irrigation, manure and insecticide are the efficiently used resources while seed is an overused one. Being ambitious of higher profit, respondents were found to use some inputs more than their required quantity. Household food security status was positively related with farm size, i.e., larger farms were found to be more food secured than the smaller ones. But contribution of maize in food security was negatively related with farm size. It means that maize contributed more in enhancing food security of the smaller farms compared to the larger ones in the study area. So, maize bore positive implication for improving household food security status of the respondents and its implication was worth mentioning in food vulnerable small farm households. As maize is a new but profitable and food security enhancing enterprise in the changing farming system, proper measures should be taken for its rapid and rational expansion in the study area as well as in other parts of the country.

References

1. Ahammed, K.M. (2009): “The Cooperative Food Bank: Quest for Sustainable Food Security of Mankind.” *Bangladesh Journal of Political Economy,* Vol 25, No. 1& 2.
2. CGIAR (1986): *Report of Consultive Group on International Agricultural Research*. New York, USA.
3. Chowdhury, M.K. and Islam, M.A. (1993): *Production and Use of Maize*. On-Farm Research Division, Bangladesh Agricultural Research Institute, Gazipur.
4. Dhawan, K.C. and Bansal, P.K. (1977): “Rationality of the Use of Various Factors of Production on Different Sizes of Farm in the Punjab”. *Indian Journal of Agricultural Economics,* Vol. 32, No. 3.
5. Doll, J.P. and Orazem, F. (1984): *Production Economics: Theory with Application.* John Wiley and Sons, New York, USA.
6. Gujarati, D.N. (2003): *Basic Econometrics*. McGraw Hill Publication, New York 10020, USA.
7. Huda, A.M.K. (2003): “Role of Credit in Maize Production and Contribution of Maize in Food Security in Lalmonirhat District of Bangladesh.” Master’s Thesis, Department of Agricultural Finance, Bangladesh Agricultural University, Mymensingh.
8. Mian, M.R.U. and Al-Imran, M. (2005): “Economics of BINA-6 Rice Production in Some Selected areas of Bangladesh.” *Journal of the Bangladesh Agricultural University,* Vol. 3, No. 2.
9. Shaner, W.W., Philipp, P.F. and Schemehl, W.R. (1982): *Farming System Research and Development: Guidelines for Developing Countries*. West view Press, Boulder, Colorado, USA.

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 093-108
Bangladesh Economic Association
(ISSN 2227-3182)

Risk and Agricultural Production- An Assessment Towards Food Security in Kurigram District of Bangladesh

Md. Rais Uddin Mian*

Abstract *Risk is an inseparable component of agriculture irrespective of its farming systems and levels of structure. It is a negative factor affecting agricultural production. So, risk should be assessed properly in undertaking strategies to attain food security. With such an objective in view the present study was conducted in Kurigram district, which is one of the most risk prone areas of the country. Three enterprises, i.e., rice, dairy and pond fish were selected and 100 respondents from 10 villages of Nageswari upazila constituted the sample for the study. Primary data were collected following survey method and both tabular and econometric techniques were used to analyze the data. It was found that a total of 7 risk factors were major threats to the selected enterprises as well as household food security in the study area. The respondents expressed that pest/insect attack was the most unfavorable factor for rice production followed by drought, input scarcity and flood. High input price followed by diseases were, respectively, the first and second threat for both dairy and pond fish enterprises. Besides, theft also hampered pond fish production in some degree. In terms of loss in money value, the most negative risk factors for rice, dairy and pond fish were flood, high input price and attack by diseases, respectively. Analysis of influencing variables in total loss showed that income and education were the risk mitigating means, which significantly and negatively influenced loss of the selected enterprises. Other variables influenced the loss positively. Attack by pest/insect was found to be the serious threat frustrating household food security position of rice producers while high input price was the same for dairy rearers and pond fish producers in the study area.*

* Associate Professor, Department of Agricultural Finance, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

1. Introduction

The performance of agriculture sector greatly determines the overall performance of Bangladesh economy. The farming system of this country is changing and it gradually takes commercial form from its traditional subsistence form. Agriculture alone generates two-thirds of the country's total employment, contributes one-fourth of total exports and provides food security for the expanding population (Ahmed and Hasan, 2009). Presently, food security is one of the vital issues which simply means the physical and economic access to sufficient food to meet dietary needs for productive and healthy life. Agriculture is the only sector, which deals this issue directly. Within the agriculture, crop, livestock and fisheries are the major sub-sectors playing important role in the socio-cultural and economic life of the people. Crop sector provides 11.16% to total GDP in which rice is the major crop and staple food and occupies more than 73 percent of total cropped area. About 82.00 percent of the total agricultural production and about 64.12 percent of total agricultural value added come from rice. Basically rice is one of the important sources of livelihood of Bangladesh. In the case of livestock, dairy plays an important role for improving human nutrition and generation of income and employment.

The contribution of livestock to total GDP is 2.41 percent. Fisheries sub sector assumes a unique status contributing 3.54% to total GDP of the country (BBS, 2011). It plays an important role in supplying protein and nutrition and earning foreign exchange for the economy. Pond fish production holds a unique status in providing employment to many households of the country. About 33 percent of total animal protein is supplied by the fisheries sub sector (MoF, 2012).

Agriculture of Bangladesh is subject to a great many risks and uncertainties. Risk is a fundamental component of agricultural production. It indicates the chances of loss of which probability distribution is known. Ability to manage risk always favors the advantage of growth opportunities (Stulz, 2003). Agricultural risk is associated with negative outcomes that stem from imperfectly predictable biological, climatic, and price variables. These variables include natural adversities (like pests and diseases) and climatic factors, which are not within the control of the farmers. The different sources of risk that affect agriculture are production risk, price or market risk, financial and credit risk, institutional risk, technological risk, personal risk, etc. Now a days, food security is a crucial issue. Therefore, in order to attain food security, impact of risks in agricultural sector should be assessed properly. Rice is the amazing grain that shapes the diets, culture, economy and the way of life in Bangladesh. But damaging rice production by continued drought and flood in many parts of the country is a common scenario. The production of rice is also affected by some risk factors like pest, input scarcity and output price variation that hampers the production of rice. The highest amount of rice area was damaged by flood in the year 2007 (BBS, 2010). Dairy rearing is more or less a profitable business and a significant number of small and landless farm families have shifted to dairying to supplement their family income. Some big commercial capital intensive dairy farms have also come up. Milk production is largely affected by some risk factors like disease, high price of inputs and milk price variation. Inadequacy of veterinary services and unfamiliarity of modern rearing techniques at grass roots level aggravates the situation. Thus, farmers always face problems to cope with risk in dairy farming. Fisheries comprises of a range of options that can be adapted to suit different needs and capacity of people of Bangladesh. But pond fish production is largely affected by some risk factors like disease, high price of input, theft, etc. Overflowing by flood, irregular supply and poor quality of water, building up organic matter in pond bottom and attack by predators are the other factors affecting negatively the pond fish production. The risk from theft and vandalism of fishes is a serious problem in some places.

It is clear that the risk in agriculture should be assessed properly to attain food security and other goals of modern agriculture. Northern part of Bangladesh is comparatively a riskier region where flood, drought and other risk factors are common in affecting agricultural production. But studies on risk are very limited in Bangladesh and in Kurigram district it is almost absent. So, this study was undertaken to make an assessment of the risk factors affecting three major sub sectors of agriculture in Kurigram district, which is one of the most risk prone areas of Bangladesh. The specific objectives of the study are a) to identify the risk factors affecting agricultural production in the study area, b) to assess the amount of losses caused by the risk factors, c) to determine the contributions of influencing variables in total losses of the selected enterprises and d) to study the perception of the respondents about the effect of risk factors on their household food security. It is expected that this study would help identify appropriately the risk factors and their contributions in total losses in the study area. It would also help the producers, credit agencies, different GOs and NGOs and researchers to undertake optimal plans for their operation incorporating appropriate risk management strategies. Thus the study provides some valuable information to attain food security coping with risks in the study area and in the country as a whole.

2. Methodology of the Study

Kurigram district was purposively selected for the study. One hundred respondents from 10 villages of Nageswari sadar upazila of the district constituted the sample of the study. Purposive random sampling technique was followed to select the respondents. Among the respondents 40 were rice producers and 30 each were dairy rearers and fish farmers. In rice producers 20 were small, 12 were medium and the rest 8 were large farmers while they were 15, 9 and 9 and 16, 9 and 5 for dairy rearers and pond fish producers, respectively. In each category, the selected enterprise was the major source of earning of the respondent. Data were collected during March to April, 2009 following survey method (Efferson, 1963) and the period of study covered 5 years before the survey year. Both descriptive and econometric techniques were followed to analyze the collected data. Descriptive technique included easy statistical tools like average, percentage, ratio, etc. Following Cobb Douglas production function (Gujarati, 2003), econometric technique employed a specified stochastic frontier function to identify the contributions of influencing variables in total losses of the enterprises. As the risk factors were not similar for all the selected enterprises, separate stochastic frontier function was used for each of the enterprises. For rice production it took the shape of:

$$\ln y_i = \ln\beta_0 + \sum_{j=1}^{3}\beta_j \ln X_{ij} + \sum_{m=1}^{4}\beta_m D_{im} + \varepsilon_i \quad , \quad i = 1, 2, 3\ldots..N$$

Where,

i = i^{th} farmer

j = j^{th} input

β_0 = intercept

β_j = coefficient of different variables

β_m = coefficient of different dummy variables

y_i = loss of i^{th} respondent (Tk) in rice production

X_{i1} = income of respondent (Tk)

X_{i2} = age of respondent (years)

X_{i3} = educational level of respondent (1, 2, 3, 4 and 5 for illiterate, sign only, primary, SSC and HSC & above respectively)

D_{m1} = dummy for drought, if affected 1, otherwise 0

D_{m2} = dummy for flood, if affected 1, otherwise 0

D_{m3} = dummy for pest/insect, if affected 1, otherwise 0

D_{m4} = dummy for input scarcity, if occurred 1, otherwise 0

ε_i = error term

N = 40 respondents

For dairy farming, the shape of production function was:

$$\ln y_i = \ln\beta_0 + \sum_{j=1}^{3}\beta_j \ln X_{ij} + \sum_{m=1}^{2}\beta_m D_{im} + \varepsilon_i \quad , \quad i = 1, 2, 3\ldots..N$$

Where,

D_{m1} = dummy for high input price, if affected 1, otherwise 0;

D_{m2} = dummy for disease, if affected 1, otherwise 0;

N = 30 respondents
and others are as defined in the equation for rice.

For pond fish production the shape of stochastic function was:

$$\ln y_i = \ln\beta_0 + \sum_{j=1}^{3}\beta_j \ln X_{ij} + \sum_{m=1}^{3}\beta_m D_{im} + \varepsilon_i \quad , \quad i = 1, 2, 3\ldots..N$$

Where,

D_{m1} = dummy for high input price, if affected 1, otherwise 0;

D_{m2} = dummy for disease, if affected 1, otherwise 0;

D_{m3} = dummy for theft, if affected 1, otherwise 0;

N = 30 respondents
and others are as defined in the equation for rice.

3. Results and Discussion

3.1 Risk Factors affecting Agricultural Production

The respondents were asked to carefully identify the risk factors that affected their production during the last five years. Among the factors identified by them, the important ones were selected for analysis.

3.1.1 Risk factors affecting rice production

As Table 1 shows, pest/insect attack was the most important risk factor affecting rice production irrespective of farm categories. It negatively affects 99.90, 94.93 and 87.50 percent of small, medium and large farms, respectively. Drought was the second important risk factor for both small and large farms (84.84 and 75.00 percent) while, flood occupied the second position in medium farm (84.21 percent) in the study area. The third important risk factor for medium farm was drought (78.95 percent). Input scarcity was also the third important risk factor for both small and large farms (75.76 and 62.5 percent, respectively). Flood and input scarcity had negative impact on the crop production of small and medium farms. Considering all farms together, pest/insect attack stood the highest in terms of negative effect on crop production as it was mentioned by maximum (91.67 percent) of the respondents. The second and third important risk factors irrespective of farm categories were drought and flood which affected 91.67 and 78.33 percent of rice producers negatively. Input scarcity was fourth in terms of intensity of effect but was a great concern because 73.33 percent of respondents suffered from scarcity of necessary inputs during their production operation. So, it can be said that all the risk factors identified were very crucial for analyzing risk in crop production in the study area.

Table 1 : Risk Factors Affecting Rice Production

Risk factors	Small farm	Medium farm	Large farm	All
Drought	28 (84.84)	15 (78.95)	6 (75.00)	49 (81.67)
Flood	24 (72.73)	16 (84.21)	7 (87.50)	47 (78.33)
Pest/insect	30 (90.90)	18 (94.93)	7 (87.50)	55 (91.67)
Input scarcity	25 (75.76)	14 (73.68)	5 (62.50)	44 (73.33)

Figures within the parentheses indicate percentages
Note: Percentages for all may not be 100 because of multiple answers given by the same respondent

3.1.2 Risk factors affecting dairy farming

It is evident from Table 2 that the small farm was most negatively affected by high input price followed by medium and large farms by 90.90, 78.94 and 75.00 percent, respectively. Effect of disease on dairy farming was in the same order where the respective percentages were 66.67, 63.15 and 62.50. Over all, high input price negatively affected 85.00 and disease so affected 65.00 percent of farms. So, high input price was the most important risk factor for dairy farming.

Table 2 : Risk Factors Affecting Dairy Farming

Risk factors	Small farm	Medium farm	Large farm	All
High input price	30 (90.90)	15 (78.94)	6 (75.00)	51 (85.00)
Disease	22 (66.67)	12 (63.15)	5 (62.50)	39 (65.00)

Figures within the parentheses indicate percentages
Note: Percentages for all may not be 100 because of multiple answers given by the same respondent

3.1.3 Risk factors affecting pond fish production

High input price was the most important risk factor for pond fish production in small farm followed by disease attack and theft, which were 90.90, 78.94 and 75.00 percent, respectively (Table 3). For medium farm, high input price was the highest risk factor followed by theft and disease attack as reported by 78.94, 73.68 and 63.15 percent of respondents, respectively. Respondents of large farm experienced both the input scarcity and theft as the most crucial risk factors (each of 75.00 percent) followed by attack of different diseases (50.00 percent). Table 3 shows that high input price was the most important risk factor followed by theft and disease attack affecting pond fish production in the areas under study.

Table 3: Risk Factors Affecting Pond Fish Production

Risk factors	Small farm	Medium farm	Large farm	All
High input price	30 (90.90)	15 (78.94)	6 (75.00)	51 (85.00)
Disease	20 (60.61)	12 (63.15)	4 (50.00)	36 (60.00)
Theft	18 (54.55)	14 (73.68)	6 (75.00)	38 (63.33)

Figures within the parentheses indicate percentages
Note: Percentages for all may not be 100 because of multiple answers were given by the same respondent

3.2 Assessment of Loss Caused by the Risk Factors

Assessment of loss by risk factor is essential to respond risk in two ways- one is selecting actions that reduce the effects of risk and another is changing the decision process (Barry, 1984). It was endeavored to assess the loss occurred by the risk factors in the study area. Loss here means negative outcome which is the difference between expected return and realized return in operation.

3.2.1 Assessment of loss in rice production

Table 4 shows that for small farm, average expected return of rice was Tk 20148, while average realized return was Tk15220, therefore average loss from rice was Tk 4927. Medium and large farms incurred loss Tk 4616 and 4250, respectively. It is clear that there prevailed a negative relationship between loss incurred and the farm size. Overall, 20.85 percent of loss was borne by the rice producers due to drought. Table 4 also indicates that maximum loss due to flood was experienced by large farms (46.00 percent) followed by medium and small farms (44.76 and 42.70 percent, respectively). So, loss of rice production due to flood maintained a negative relationship with farm size. Rice losses due to attack by pest/insect was the highest in small farm as the loss was 28.93 percent of total expected return. The losses were 25.47 percent in medium farm and 21.73 percent in large farm. The loss of all farms showed a negative relationship between them. The maximum 19.37 percent of expected return was not realized by the small farms due to non-availability of production inputs. The losses of the medium and large farm were 18.99 and 18.12 percent, respectively. So, a negative relationship was also found between farm size and loss for input scarcity. For all farms, loss due to flood was the highest (44.49 percent) of expected return. The losses by pest/insect, drought and input scarcity were 25.42, 20.85 and 18.84 percent, respectively. So, flood

Table 4 : Average Annual Loss Caused by Risk Factors in Rice Production

Risk factors	Return	Small farm (Tk/acre)	Medium farm (Tk/acre)	Large farm (Tk/acre)	All (Tk/acre)
	Expected	20148	20993	24970	22037
	Realized	15220	16376	20720	17439
Drought	Loss	4928	4617	4250	4598
		(24.45)	(21.99)	(17.02)	(20.85)
	Expected	21091	21150	21303	21181
	Realized	12084	11682	11503	11756
Flood	Loss	9007	9467	9800	9425
		(42.70)	(44.76)	(46.00)	(44.49)
	Expected	20913	20229	20171	20438
	Realized	14861	15075	15787	15241
Pest/insect	Loss	6052	5154	4384	5197
attack		(28.93)	(25.47)	(21.73)	(25.42)
	Expected	20699	20142	20080	20307
	Realized	16688	16316	16440	16481
Input	Loss	4011	3826	3640	3826
scarcity		(19.37)	(18.99)	(18.12)	(18.84)

Figures within parentheses indicate percentages of expected return was the most important risk factor affecting rice production negatively in the areas under study.

3.2.2 Assessment of loss in dairy farming

Input price hike and fluctuation is a common phenomenon in the economy of Bangladesh. Farmers faced loss in dairy farming for the high price of different inputs (straw, concentrated feed, etc.). Table 5 indicates that for small farm, average expected return from dairy was Tk 19573, while average realized return was Tk 15713, therefore average loss was Tk 3860. For medium and large farms, average losses were Tk 3632 and 3200, respectively. The table shows that there prevailed a negative relationship between loss incurred and the farm size. Overall, 19.11 percent of loss was faced by the dairy farmers due to high input price. Disease outbreaks reduce yield and cut profit margins and farmers incurred loss in dairy farming. Table 5 shows that maximum of loss due to different diseases were experienced by small farms (19.53 percent) followed by medium and large farms (18.81 and17.48 percent, respectively). So, loss of dairy farming due to different diseases had a negative relationship with farm size. Considering all farms together, loss for dairy farming due to high price of inputs was the highest (19.11 percent) followed by attack of different diseases (18.81 percent).

Table 5 : Average Annual Loss Caused by Risk Factors in Dairy Farming

Risk factors	Return	Small farm (Tk)	Medium farm (Tk)	Large farm (Tk)	All (Tk)
	Expected	19573	18950	17416	18646
High input price	Realized	15713	15318	14216	15082
	Loss	3860	3632	3200	3564
		(19.72)	(19.16)	(18.37)	(19.11)
	Expected	20872	18075	18640	19195
	Realized	16795	14575	15380	15583
	Loss	4077	3400	3260	3612
Disease		(19.53)	(18.81)	(17.48)	(18.81)

Figures within parentheses indicate percentages of expected return

3.2.3 Assessment of loss in pond fish production

Farmers incurred loss in fish farming for the high price of different inputs. It was evident that the highest 21.93 percent of expected return was not realized by the small farm due to high price of production inputs (Table 6). The losses of medium and large farms were 19.71 and 18.86 percent, respectively. So, a negative relationship was found between farm size and loss for high price of production inputs. Attack by diseases in pond fish production causes huge loss in fish farming and farmers have to cope with these risk factors. Table 6 indicates that the loss due to different diseases was the highest in large farms (28.18 percent of total expected return). The losses were 27.65 percent in medium farms and 23.35 percent in small farms. The risk by theft and vandalism was also a problem and negatively affected pond fish production. Table 6 shows that maximum of loss due to theft was experienced by large farms (23.06 percent) followed by medium and small farms (22.23 and 20.06 percent, respectively). So, loss of fish farming due to theft maintained a positive relationship with farm size. Considering all farms together, loss in fish farming due to disease was the highest (26.43 percent of the expected return). The losses were 21.85, and 20.49 percent by theft and high price of production inputs, respectively. So, disease was the most important risk factor affecting fish farming negatively in the areas under study.

Table 6 : Average Annual Loss Caused by Risk Factors in Pond Fish Production

Risk factors	Return	Small farm (Tk/acre)	Medium farm (Tk/acre)	Large farm (Tk/acre)	All (Tk/acre)
High input price	Expected	93077	96242	97266	95528
	Realized	72261	76666	78916	75948
	Loss	20416 (21.93)	18976 (19.71)	18350 (18.86)	19580 (20.49)
Disease	Expected	90691	93975	94300	92988
	Realized	69511	67988	67725	68408
	Loss	21180 (23.35)	25987 (27.65)	26575 (28.18)	24580 (26.43)
Theft	Expected	90030	90350	99200	93193
	Realized	71968	70183	76316	72822
	Loss	18062 (20.06)	20167 (22.23)	22884 (23.06)	20371 (21.85)

Figures within parentheses indicate percentages of expected return

3.3 Contributions of Influencing Variables in Loss of Enterprises

3.3.1 Contributions in loss of rice production

Table 7 indicates that all independent variables other than income and education are positively significant. The regression co-efficients of drought, flood, pest/insect and input scarcity indicate that they affected rice producer's loss by 33.4, 41.5, 20.5 and 11.5 percent, respectively, higher than the farmers who were not affected by these variables. The co-efficients of income and education were negative and significant. It indicates that 1 percent increase in income and education level would decrease the loss by 25.8 and 4.3 percent, respectively. It clears the importance of education in risk management. As risk management is a technical consideration, relatively higher educated persons can employ the mitigating strategies more successfully than the illiterate or lower educated ones. The co-efficient of multiple determination, R^2, was 0.956, which indicates that about 96 percent of the variations of loss in rice production were explained by the independent variables included in the model. The F-value of the equation was highly significant implying that all the variations in loss of rice production depended mainly upon the explanatory variables included in the model.

3.3.2 Contributions in loss of dairy farming

It can be seen in Table 8 that income and education are negatively related with loss in dairy farming and they were significant at 10 and 5 percent levels, respectively.

Table 7 : Estimated Values and Related Statistics of Stochastic Frontier Function for Rice Production

Variable/parameter	Co-efficient	t-value
Intercept	4.960^{***} (1.398)	3.571
Income (X_1)	-0.258^{**} (0.152)	-1.697
Age (X_2)	-0.027 (0.094)	-.287
Education (X_3)	-0.043^{***} (0.020)	-2.150
Dummy for drought (D_1)	0.334^{***} (0.039)	8.564
Dummy for flood (D_2)	0.415^{***} (0.037)	11.216
Dummy for pest/insect (D_3)	0.205^{**} (0.044)	4.659
Dummy for input scarcity (D_4)	0.115^{**} (0.052)	2.212
R^2 (adjusted)	0.956	-
F-value	467.209	-

Figures within parentheses indicate standard error

***significant at 1% level

** significant at 5% level

It means that keeping other variables constant, 1 percent increase in income and education would decrease loss in dairy farming by 14.6 and 11.7 percent, respectively. The co-efficients of high input price and disease indicate that they affected dairy farmers' loss by 16.7, and 14.3 percent higher than the farmers who were not affected by these variables. The co-efficient of multiple determination, R^2 was 0.613, which means that about 61 percent of the variations of loss was explained by the independent variables included in the model. The highly significant F-value implies that all the variations in loss of dairy farming depended mainly upon the explanatory variables.

Table 8 : Estimated Values and Related Statistics of Stochastic Frontier Function for Dairy Farming

Variable/parameters	Co-efficient	t-value
Intercept	5.402*** (0.506)	10.681
Income (X_1)	-0.146* (0.087)	-1.687
Age(X_2)	-0.232 (0.222)	-1.044
Education (X_3)	-0.117** (0.030)	-3.9
Dummy for high input price(D_1)	0.167*** (0.058)	2.889
Dummy for disease(D_2)	0.143** (0.058)	2.483
R^2 (adjusted)	0.613	-
F-value	19.706	-

Figures within parentheses indicate standard error

*** significant at 1% level

** significant at 5% level

* significant at 10% level

3.3.3 Contributions in loss of pond fish production

Table 9 shows that all the independent variables included in the model were positive except income and education. The significant regression co-efficients of income and education implies that 1 percent increase in these variables would decrease the loss by 11.5 and 1.6 percent, respectively. The co-efficients of high input price, disease and theft indicate that they affected fish farmer's loss by 18.90, 13.00 and 33.30 percent higher than the farmers who were not affected by these variables. Value of R^2 shows that about 85 percent of the variations of loss was explained by the independent variables. The highly significant F-value means that all the variations in loss of pond fish production depended mainly on the explanatory variables.

Table 9 : Estimated Values and Related Statistics of Stochastic Frontier Function for Pond Fish Production

Variable/ parameters	Co-efficient	t-value
Intercept	8.065*** (0.627)	12.862
Income (X_1)	-0.115*** (0.035)	-3.270
Age(X_2)	-0.092 (0.101)	-0.912
Education (X_3)	-0.016* (0.012)	-1.320
Dummy for high input price (D_1)	0.189*** (0.053)	3.583
Dummy for disease (D_2)	0.130*** (0.027)	4.898
Dummy for theft (D_3)	0.333*** (0.053)	6.263
R^2 (adjusted)	0.853	-
F-value	58.180	-

Figures within parentheses indicate standard error

*** significant at 1% level

* significant at 10% level

3.4 Perception of Respondents about Effects of Risk Factors on Household Food Security

The respondents were asked what they thought about the identified risk factors as threat to their household food security. The opinions of the respondents were collected under three categories of threat, i.e., severe, moderate and low, which are presented in Table 10. Pest/insect attack was the most frustrating risk factor to food security of the rice producers as highest proportion of the respondents (57.00 percent) reported this problem. Drought and flood emerged as second joint damaging factors, which were mentioned by 50.00 percent of the rice producers. Input scarcity was not a major threat to food security of the respondent households. The respondents expressed that though flood and drought are major risk factors, they maintained more or less a regular interval in their occurrence. But attack by insect/pest causes frequent damage in rice production, which was a major concern of the rice producers.

In dairy production, high input price is the major risk factor and 60.00 percent of dairy farmers reported it as a threat to their food security. Next to it, attack by diseases was the threat which was felt by 46.67 percent of the respondents. High

Table 10 : Perception of Risk Factors affecting Food Security

Enterprise	No. of respondents	Risk factors	Perception in terms of threat to household food security (no. of respondents)		
			Severe	Moderate	Low
Rice	40	Drought	20 (50.00)	16 (40.00)	4 (10.00)
		Flood	20 (50.00)	15 (37.50)	5 (12.50)
		Pest/insect	23 (57.00)	11 (27.50)	6 (15.00)
		Input scarcity	9 (22.50)	13 (32.50)	18 (45.00)
Dairy	30	High input price	18 (60.00)	8 (26.67)	4 (13.33)
		Disease	14 (46.67)	10 (33.33)	6 (20.00)
Pond fish	30	High input price	17 (56.67)	9 (30.00)	4 (13.33)
		Disease	10 (33.33)	15 (50.00)	5 (16.67)
		Theft	7 (23.33)	7 (23.33)	16 (53.33)

Figures within the parentheses indicate percentages

input price was also mentioned as a threat to food security by 56.67 percent pond fish farmers. Attack by diseases and theft were more or less moderate (50.00 percent) and low (53.33 percent) negative factors, respectively, affecting food security position of the respondents. All the identified risk factors frustrated the household food security position of the respondents. Among them pest/insect attack and high input price were the matters of major concern.

4. Conclusion

Farming system is a dynamic process where changes are essential to ensure profitability of farming and to attain food security of the producers. But risk is an impediment in this process. In the study area, several risk factors affected agricultural production adversely. Among them seven factors were prominent. These are insect/pest, flood, drought, input scarcity, high input price and diseases. Attack by insect/pest, flood and drought were the most important threats to the rice producers while high input price was the major threat for both dairy rearers and pond fish producers. But one thing is clear that all the risk factors reduce farm income and frustrate household food security of the respondents seriously. As risk cannot be avoided fully, proper measures should be taken from both government and non-government levels so that the adverse effects of risk could be mitigated and advantages of changing farming system could be enjoyed to attain food security of the country.

References

1. Ahmed, M.F. and Hasan, F. (2009): "Agriculture and Food Security in Bangladesh: How Climate Change Affects the Extreme Poor?" *Bangladesh Journal of Political Economy*, Vol. 25, No. 1&2.
2. Barry, P.J. (1984): *Risk Management in Agriculture*. Iowa State University Press, Anes, Iowa, USA.
3. BBS (2010).
4. BBS (2011): *Yearbook of Agricultural Statistics of Bangladesh-2010*. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Dhaka.
5. BBS (2012): *Statistical Yearbook of Bangladesh-2011*. Bangladesh Bureau of Statistics, Statistics and Information Division, Ministry of Planning, Dhaka.
6. Efferson, J.N. (1963): *Principles of Farm Management*. McGraw Hill Book Company, Inc, New York.
7. Gujarati, D.N. and Sangeetha (2007): *Basic Econometrics*. Tata McGraw-Hill Publishing Company Limited, New Delhi.
8. MoF (2012): *Bangladesh Economic Review*. Finance Division, Ministry of Finance, Dhaka.
9. Stulz, R. (2003): *Risk Management and Derivatives*. Cengage Learning India Private Limited, New Delhi.

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 109-126
Bangladesh Economic Association
(ISSN 2227-3182)

Rice-sunflower Cropping Pattern and its Contribution to Income and Food Security of Polder Farmers

MAHNAZ AFSAR*
MAHBUB HOSSAIN**
TOFAZZAL HOSSAIN MIAH**

Abstract *This study mainly examined the relative profitability of the new rice-sunflower cropping pattern over traditional rice-sesame and also to assess impacts of the new cropping pattern on income earning and food security of households in a polder area under Batiaghata Upazila of Khulna district in Bangladesh. In total, 200 farmers were selected for the study. Descriptive statistics, activity budgets, logit model, food security index and partial budget were employed to achieve the objectives. The study confirmed that both the traditional T. Aman rice-sesame and new T. Aman rice-sunflower cropping patterns were profitable. Per hectare net return from new rice-sunflower pattern was relatively much higher (Tk 75,385.00/ha) than that of the traditional rice-sesame pattern (Tk 39,354.00/ha). The results of logit model indicate that five variables out of seven have influences on household's food security. The results of regression analysis indicate that the age of household head, involvement in off-farm activities, total income and food expenditure have had positive association while family size had a negative association with food security status of the households. The average daily per capita calorie intake was relatively higher for the followers of rice-sunflower*

* The author is a post-graduate student;
** The authors are Assistant Professor and Professor, respectively in the Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh. The article is based on first author's Master's thesis submitted to the Department of Agricultural Economics, BAU Mymensingh, Bangladesh. The authors are grateful to International Water Management Institute (IWMI), New Delhi, for providing funds for conducting this study here in Bangladesh.

cropping pattern (2273.37 kcal/day) than that of the traditional rice-sesame growers (2046.80 kcal/day). The estimated food security indices for rice-sesame and rice-sunflower farmers were 0.95 and 1.00, respectively. The result of partial budget analysis revealed that the new sunflower producing households were earning much higher income than the sesame growing farmers. The study also identified farmer's perception about the new cropping pattern. It is concluded that the rice-sunflower cropping pattern has had some positive impacts on income earning and household food security of the polder farmers.

1. Introduction

The coastal area of Bangladesh covers about 20.0 percent of the whole country and over 30.0 percent of the cultivable area. About 53.0 percent of the coastal areas are affected by salinity. Agricultural land use in this area is very poor, which is roughly 50.0 percent of the country's average (Haque, 2006). Salinity causes unfavorable environment and hydrological situation that restrict the normal crop production throughout the year. Most of the lands remain fallow in the dry season (January to May) because of soil salinity and the lack of good-quality irrigation water. Supplying farmers with alternative production systems with high land and water productivity is crucial for food security, enhancing farmers' livelihood and sustaining the environment of the coastal zone. In other words, proper water management and irrigation system is very important to adopt new cropping pattern in this coastal area.

The cropping pattern usually followed in the study area is mainly sesame-*T. Aman* rice. Sesame is a summer crop and highly susceptible to water logging. Production of Sesame fluctuates widely, depending on the rainfall pattern and other environmental factors. Sunflower is a photo and thermo-neutral oilseed crop and grows well in both *Rabi* and *Kharif* seasons of Bangladesh (Saha, 1995). Per unit production of sunflower is relatively higher than the sesame and relatively less risky to grow in this area. It is, therefore, prospective and important to diversify the oilseed production through the introduction of new crop like sunflower.

Innovations in crop production and adopting new cropping pattern can play a major role in helping farmers adapt to extreme conditions and secure livelihoods in the coming years. The oilseed section of Bangladesh Agricultural Research Institute (BARI) has been conducting experiments at various sub-stations of the country. Bangladesh Rural Advancement Committee (BRAC) has also been trying to introduce rice-sunflower instead of old pattern for betterment of polder farmers.

This new cropping pattern (i.e., rice-sunflower) can perhaps give better farm income than any other existing cropping pattern and the new pattern might have some positive impacts on food security of the polder farmers. Unfortunately, no hard data are available to the farmers on these particular issues. The present study has, therefore, been designed to assess the impact of adopting new cropping pattern and also to assess whether this new pattern is more profitable over the traditional rice-sesame cropping pattern in this polder area or not.

Mannaf (2012) conducted a study on the profitability of maize production and its impact on food security. The results revealed that the rural households were food secured; it was checked by using recommended minimum calorie requirement (i.e., 2122 kcl). Nasrin (2011) studied the land tenure system and assessed its impact on food security. The study confirmed that the extent of food security situation was much better among the cash tenant households than that of the share tenant households and thereby land tenure systems affect the food security situation of the households. A logistic regression was used by Kidane *et al.* (2005) and Feleke *et al.* (2005) to assess the causes of household food insecurity. The productivity and profitability of rice and oilseed farming and studies related to food security throughout the world were conducted but comparative profitability of sunflower and sesame cultivation and their impacts on household income and food security have not yet been done in Bangladesh. Although the cultivation of sunflower started from many years ago in Bangladesh, it failed to gain popularity as edible oil and surprisingly only a few literatures are available in this country. In other words, farm management research has not yet been conducted to identify the impact of rice-sunflower cropping pattern over traditional rice and sesame cropping pattern on household income and food security of the farmers in polder area. This study is, therefore, completely a new and pioneering one. The study was undertaken with the following specific objectives:

i. to assess the relative profitability of adopting rice-sunflower over traditional rice-sesame cropping pattern;
ii. to identify the factors influencing the food security status of farming households;
iii. to estimate the contribution of new pattern to the household income and food security; and
iv. to assess the perception of the farmers towards the new cropping pattern.

2. Research methods

Five adjacent villages namely Amtola, Baruiabad, Titukhali, Debitola, and Boyervanga of polder number 30 from Batiaghata Upazila in Khulna district of

Bangladesh have purposively been selected for the study. In total 200 farmers, 100 from each of the selected cropping patterns were selected for the study. A simple random sampling technique was followed for traditional rice-sesame farmers while purposive sampling was employed for selecting new rice-sunflower farmers. Primary data were collected using a structured interview schedule. The relevant secondary data were collected from the concerned government and research reports, online materials and periodicals. The formal data for the study were collected during the August-September 2012. It was, of course, a normal year. Data were collected through direct interviews by making personal visits to the houses of the selected individual farmers. Activity budget (see Dillon and Hardaker 1993) is the most common method in determining and comparing the profitability of enterprise activities. Profit is defined as the difference between the total revenue and total cost. The following profit equation was employed to prepare activity budgets of the selected crops like rice, sesame and sunflower from the viewpoints of individual farmers:

$\pi = TR - TC$

Or, $\pi = TR - (VC + FC)$

Where,

π = Net returns (Tk/ha);

TR = Total return (Tk/ha);

VC = Variable cost (Tk/ha);

TC = Total cost involved in producing the concerned crops.

To assess the impact of new pattern and factors influencing the food security status of farming households two stages of analysis were done. At first, a food security index (Z) was constructed and food security status of each household was determined based on the food security line using the recommended daily calorie intake approach and then a logit model was used to estimate the food security status of household as a function of a set of independent determinants. A household which had daily per capita caloric intake up to 2122 kcal was regarded as food secure and those below 2122 kcal were regarded as food insecure households.

The mathematical representations are as follows:

$Zi = Yi/R$ (Babatunde *et al.* 2007)

Where.

Z_i = Food security status of i^{th} households which take values of 1 for food secure households or 0 for food insecure households;

Y_i = Daily per capita calorie intake of i^{th} household;

R = Recommended Per capita daily calorie intake; and

I = 1,2,3,…….,100.

Based on the household food security index (Z), the Logit model was estimated to identify the determinants of food security to assess the impact of rice-sunflower cropping pattern on food security.

The implicit form of the model was as follows:

$Z_i = \beta X_i + U_i$ (Babatunde *et al.* 2007)

Where,

Z_i = the food security stains of i^{th} household;

X_i = Vector of explanatory variables;

U_i = Error term; and

β = Vector of parameter estimates.

The explanatory variables included in the model were:

X_1 = Household size;

X_2 = Age of household head;

X_3 = Farm size;

X_4 = Per capita production;

X_5 = Household income;

X_6 = Involvement in off farm activities;

X_7 = Food expenditure;

To measure the impact of rice-sunflower cropping pattern on household food security the food insecurity gap, the surplus index and the headcount ratio of food security were calculated for the sample households based on food security line.

Surplus index or food insecurity gap was used to measure the extent to which a household is food secure or insecure.

The index is given as:

P = $\frac{1}{M}\sum_{i=1}^{m} Gi$ (Babatunde *et al.* 2007)

Where,

P = Surplus index or food insecurity gap;

M = Number of household that are food secured (for surplus index) or food insecured (for food insecurity gap); and

G_i = Per capita calorie intake deficiency (or surplus) faced by i^{th} household.

$G_i = \left(\frac{Yi-R}{R}\right)$ (Babatunde *et al.* 2007)

The head count ratio measures the percentage of the population of household that are food secured or insecured.

This is defined as:

H= $\frac{M}{N}$ (Babatunde *et al.* 2007)

Where,

H = Head count ratio;

M = Number of individuals that are food secured (for surplus index) or food insecured (for food insecurity gap); and

N = Population size.

Partial budget was employed to assess the impact of rice-sunflower cropping pattern on household income. It was used to compare the costs and benefits of alternatives faced by farm business. The costs and revenues needed for a partial budget can be identified by considering the following four basic questions about a proposed change (such as switching from traditional sesame to new sunflower cultivation:

a. What new or additional costs will be incurred?
b. What current costs will be reduced or eliminated?
c. What new or additional revenue will be received?
d. What current revenue will be lost or reduced?

3. Results and discussion

Profitability of *T. Aman* Rice, Sesame and Sunflower Production

A quick way to assess the profitability was to calculate gross return and gross cost. To obtain the value of net return, both cost of production and value of output

Table 1 : Summary Results of Growing of T. Aman Rice, Sesame and Sunflower per Hectare

Particulars	T Aman rice	Sesame	Sunflower
A. Gross returns (Tk/ha)	56,238.00	41,888.00	103,501.00
B. Gross costs (Tk/ha)	35,270.00	23,502.00	49,084.00
C. Net returns (Tk/ha)	20,968.00	18,386.00	54,417.00
D. BCR (Undiscounted)	1.59	1.78	2.11

Sources: *Adapted from Appendix Tables 1, 2 and 3*

(gross return) were calculated. The results of the estimation of the costs and returns have been made by employing individual activity budgets and presented in Appendix Tables 1, 2 and 3. The summary results of the profitability analysis of T. Aman rice, sesame and sunflower are presented in Table 1. Since T. Aman rice cultivation was the most common in both the selected new and traditional cropping patterns in the polder area, the difference in profitability between sunflower and traditional sesame was very important.

It is evident from the summary results presented in Table 1 that the farmers were earning much higher profit per hectare by cultivating new sunflower (Tk 54,417.00/ha) than the traditional sesame (Tk 18,386.00/ha). The undiscounted BCR (Benefit-cost ratio) of sunflower production is also much higher (2.11) than the cultivation of sesame (1.78). The findings clearly indicate that the farmers of the polder area can have much higher net return per hectare by adopting sunflower.

New Rice-Sunflower versus Traditional Rice-Sesame Cropping Pattern

Table 2 shows the positive impact of adopting new rice-sunflower cropping pattern over the traditional rice-sesame on income earning of the polder farmers.

Table 2 : Impact of Adopting New Rice and Sunflower Pattern over Traditional Rice and Sesame on per Hectare Net Return

Particulars	New rice-sunflower pattern	Traditional rice-sesame pattern	Impact of new over traditional pattern
A. Net returns (Tk/ha)	75,385.00	39,354.00	+ 36,031.00
B. BCR (Undiscounted)	1.89	1.67	+ 0.22

Sources: *Adapted from Appendix Tables 1, 2 and 3.*

Both per hectare net return (Tk 75,385.00/ha) and undiscounted BCR (1.89) of T Aman rice-sunflower cropping pattern were much higher than the followers of the traditional T Aman rice-sesame pattern. In other words, a farmer can have an extra amount of Tk 36,031.00 profit from a hectare of cultivable land by adopting new T Aman rice-sunflower cropping pattern.

The results presented in Appendix Tables 1, 2 and 3 revealed that per hectare cost of sunflower cultivation was much higher than that of the sesame and rice cultivation, since the costs of seeds, fertilizers and human labours were relatively much higher for sunflower cultivation. Most of the farmers did not use any fertilizer for sesame cultivation which was followed by T Aman rice cultivation. Since sunflower farmers had to apply fertilizers in their crop-field and the sowing method of sunflower was also different from sesame, human labour for sunflower cultivation was much higher than that of the sesame. For producing rice and sesame farmers did not use irrigation water but sunflower production farmers had to apply irrigation water.

The findings clearly indicate that production of T. Aman rice, sesame and sunflower was profitable from the viewpoints of individual farmers, although there are some differences in profitability among these selected individual crops. There was a significant difference in profitability between the followers of the rice-sunflower cropping pattern and traditional rice-sesame cropping pattern. The

Table 3 : Estimation of the Logistic Regression of Determinants of Food Security Status of Farm Household

Variable	Coefficient	Standard Error	Level of Significance	Exponential coefficient odds ratio
Constant	-3.837	1.533	0.012	0.022
Household size	-0.726	0.320	0.023*	0.484
Age of household head	0.011	0.019	0.544	1.011
Farm size	0.586	0.851	0.492	1.796
Per capita production	0.003	0.001	0.052**	1.003
Income	0.002	0.001	0.005*	1.002
Involvement in off farm activities	0.920	0.509	0.070***	2.510
Food expenditure	0.002	0.001	0.003*	1.002

Source: *Adapted from Afsar (2013, p. 73).*

Note: * indicates significant at 1% level

** indicates significant at 5% level

*** indicates significant at 10% level

main reason was that per hectare yield of sunflower was much higher in polder area than that of the traditional sesame. The Sunflower cultivation provided a higher net return to the farmers due to its higher yield potential. Despite of some marketing problems, the new rice-sunflower cropping pattern has currently been gaining popularity in the polder area day by day.

Factors Influencing the Food Security Status of Farming Households

For assessing determinants of farm household's food security, logit model was estimated. Seven explanatory variables were identified to be major determinants of food security in this study. Among the seven factors considered in the model, five were found to have a significant impact in determining household food security (Table 3). These are household size, per capita production, household income, involvement in off farm activities and food expenditure.

Large household size exerts more pressure on consumption. The per capita food availability declines as family size increases due to population growth. The coefficient of household size which was significant at 1 percent level, -0.726 means there is a negative relationship between household size and food security and odds ratio was 0.484 means a unit increase in household size will reduce the probability of household to be food secure by 0.484.

The age of household head had a positive coefficient but statistically insignificant indicating that the older the household head, the higher the probability that the household would be food secures.

The larger the farm size, the higher the production level. It is thus expected that households with larger farm size are more likely to be food secure than those with smaller farm size. The coefficient of farm size was 0.586 and the odds ratio was 1.796 which was positive but statistically insignificant.

Per capita aggregate production was computed by dividing the output realized by the farm family after deducting all kinds of payments and post harvest losses, by the household size. This result implies that per capita aggregate production was positive and significant at 5 percent level. This indicates that the higher the per capita aggregate production, the higher is the probability that the household would be food secure. A unit increase in per capita production will increase the probability of household to be, food secure by 1.003.

The income is expected to boost household's food production and also access to more quantity and quality food. Household's income was positive and significant at 1 percent level, indicates that the higher the household income, the higher is the probability that the household would be food secure. A unit increase in the level of income will increase the probability of household to be› food secure by 1.002.

Off-farm activities was measured based on whether or not the household was engaged in off-farm activities. A household which was not engaged in off-farm activities takes the value zero and the household with off-farm activities takes the value one. It enables farmers to modernize their production by giving them an opportunity for applying the necessary inputs. Involvement in off farm activities was positive and significant at 10 percent. This indicates that households which were engaged in non-farm activities were nearly 2.51 times likely to food secure than those households who were not engaged in off farm activities, other things remaining the same.

Food expenditure has a low but positive coefficient that was significant at 1 percent level. A unit increase in food expenditure increase, the probability of household to be food secure by 1.002. This indicates that the higher the amount of food expenditure i.e. the higher the amount of taka spend on food purchase, the higher the likelihood of food security.

Table 4 : Food Security Indices for Sampled Farm Household under Two Cropping Patterns

Categories	Food security indices	Food secure households	Food insecure households	All
Rice-sesame	Food security index	1.05	0.85	0.95
	Percentage of households	50.00	50.00	100
	Per capita daily calorie availability (kcal)	2236.97	1806.15	2046.80
	Food insecurity gap/ surplus index (P)	0.05	-0.15	-
	Head count index (H)	0.50	0.50	-
Rice-sunflower	Food security index	1.07	0.90	1.00
	Percentage of households	60	40	100
	Per capita daily calorie availability (kcal)	2271.52	1919.18	2273.37
	Food insecurity gap/ surplus index (P)	0.07	-0.10	-
	Head count index (H)	0.60	0.40	-

Source: *Adapted from Afsar (2013, p. 76).*

Impact of Rice-Sunflower Cropping Pattern on Household Food Security

Table 4 shows the per capita daily calorie intake from different food items by the households. Average per capita calorie intake by households under rice-sesame cropping pattern was estimated 2046.80 kcal which is lower than the recommended daily calorie intake 2122 kcal per day. The average per capita calorie intake was relatively higher for the households under rice-sunflower cropping pattern which was 2273.37 kcal and above than the recommended daily calorie intake 2122 kcal per day.

Results of food security index indicated that per capita calorie intake varied between two categories of farmers. Among the rice-sesame farmers 50.00 percent households were food secure and obtained 2236.97 kcal per capita per day. The rest of the farmers were food insecure. The food security index for rice-sesame farmer was 1.05; the value of this index for insecured households it was 0.85. The food security gap or surplus index shows that the food secure households exceeded the food poverty line by 5.00 percent, while food insecure households fell short of the required calorie intake by 15.00 percent. Farmers who follows rice-sesame cropping pattern in the study area could be regarded as food insecured though 50.00 percent of the selected households were food secured; because their (food secured and insecured households) average daily calorie intake was 2,046 kcal per day per capita which was lower than the required calorie intake of 2,122 kcal.

Table 4 shows that farmers who cultivated sunflower in the study area could be classified as food secure, given the fact that only 40.00 percent of the sampled households were not able to meet the recommended calorie intake of 2,122 kcal per capita per day. About 60.00 percent farmers of rice-sunflower farmers were food secure and obtained 2271.52 kcal per capita per day. The surplus/shortfall index (P) shows that the food secure households exceeded the calorie requirements by 10.0 percent, while the food insecure households was 7.0 percent less than the minimum recommended calorie intake. So, rice-sunflower cropping pattern clearly affect the food security situation of selected households.

Impact of Rice-Sunflower Cropping Pattern on Household Income

The additional income from sunflower production had a significant contribution to total household income of the sunflower growers. Table 5 reveals that the net change in profit, as stated before, is Tk. 36,031.00 because revenue from sunflower cultivation is higher than sesame though its cost of production is higher. If farmers replace sesame with sunflower they can obtain additional Tk. 36,031.00 per hectare.

Table 5 : Partial Budget Analysis for the Replacement of per Hectare Sesame with Sunflower

Items	Debit (Tk/ha)	Items	Credit (Tk/ha)
a. Cost for new sunflower cultivation	49,084.00	a. Additional revenue for sunflower cultivation	103,501.00
b. Revenue foregone for sesame	41,888.00	b. Cost saved for not cultivating sesame	23,502.00
Total	90,972.00	Total	127,003.00
Net change in farm income (Tk/ha) = (127,003.00 – 90,972.00) = 36,031.00			

Source: *Adapted from Afsar (2013, p. 77).*

The key point which has been explored through this discussion is that, households following rice-sunflower cropping pattern have higher income and better food security status than those who have not been producing sunflower in the study area.

Farmers' Perception about Sunflower Cultivation

The responses of farmers regarding sunflower cultivation were analyzed and presented in Table 6. After realizing the positive impacts of sunflower farming on household income and food security many farmers were willing to choose rice-sunflower cropping pattern. Some farmers have had an innovative idea to grow sunflower; and some of them are still hesitating to grow this crop.

Some farmers were a bit worried about the risk of adopting a new crop like sunflower in their cropping pattern. As the production cost of sunflower is relatively higher than the sesame many of them were hesitating to produce sunflower. On the other hand, farmers who produced sunflower did not get the fair price for their product. In the study area, there is no formal market for sunflower. As a consequence, many of sunflower producers were uncertain to get fair price of their product and often they could not sell sunflower to nearby market when farmers were required some cash to meet basic needs of households. Despite the fact, some farmers were interested to cultivate sunflower as they knew about the higher per hectare yield of sunflower. Sunflower is mainly grown in the study area for edible oil and it was used mainly for cooking purposes in the households. Another advantage was that the farmers who grew sunflower did not buy edible oil like soybean and/or mustard oil from market by spending their huge amount of household income. Nevertheless, the current adoption rate of sunflower is, perhaps, far better than ever before.

The farmers were divided into three groups. Some of them wanted to cultivate only sesame, some of them wanted to cultivate only sunflower and the third group wanted to cultivate both sesame and sunflower. In the study area 40.00 percent farmers gave their opinions in favour of only sesame production since its production technique is very simple and well known to them; and they can have cash by selling it at any time in the local market. 25.00 percent of the total sampled farmers were in favour of sunflower production. Meanwhile, these farmers have had a good impression about sunflower production. The reasons behind this positive attitude about sunflower cultivation were that they could properly utilize their land as well as surplus family labour; also met the demand of edible oil from owned households and having profit.

Finally, 70 farmers were in favour of both sesame and sunflower production which was 35.00 percent of the total due to the suitability of land area, facility of irrigation water (Table 6). They argued that all lands were not suitable for sunflower cultivation since irrigation facilities were not available to those plots.

Table 6 : Farmers' Willingness toward Crop Production

Farmers' opinions regarding crop cultivation	Number of respondents	% of total
In favour of sesame cultivation	80	40.00
In favour of sunflower cultivation	50	25.00
In favour of both sesame and sunflower cultivation	70	35.00
Total	200	100.00

Source: *Adapted from Afsar (2013, p. 80).*

4. Policy Implications and Conclusion

This study confirmed that the rice-sunflower cropping pattern is more profitable than the traditional rice-sesame pattern from the viewpoints of individual farmers. Sesame growing farmers had to face a lot of crucial problems such as saline water, water logging and risk of yield variability due to rainfall. To reduce these problems as well as risk of growing sesame, sunflower may be considered as a risk-free, high yielding and income generating good substitute for sesame. The concerned extension and NGO officials should, therefore, encourage farmers to adopt this new pattern in polder areas of Batiaghata Upazila in Khulna district for making more household income and food security.

As marketing system of sunflower as a completely new crop has not yet been developed in the study area, many local farmers are still in horns of a dilemma whether or not they should grow sunflower in their plots although it is a profitable crop. This profit could further be increased if efficient marketing system could be developed within the shortest possible time in the study area. The policy makers and/or concerned officials must pay an immediate attention to solve marketing problems of the sunflower farmers.

It can, therefore, cautiously be concluded that this new rice-sunflower cropping pattern positively affects the farm productivity and food availability at the household level and thereby overall food security of the polder farmers. The new rice-sunflower cropping pattern can be adopted elsewhere in the polder areas and thus the farmers can have higher household income and better food security status than followers of those of the traditional rice-sesame cropping pattern.

References

1. Afsar, M. (2013), "Impact of rice-sunflower cropping pattern on income and food security of farm households in Polder 30 of Batighata Upazila in Khulna district of Bangladesh". MS Ag Econ thesis, Bangladesh Agricultural University, Mymensingh.
2. Babatunde, R.O., Omotesho,O.A. and Sholotan,O.S. (2007), 'Factor influencing food security status of rural farming households in North Central Nigeria', Agricultural Journal 2(3), 351-57.
3. Dilon, J.L. and Hardaker, J.B. (1993), Farm Managent ant Research for Small Farmers Development, UNFAO, Rome.
4. Feleke, S. T., Kilmer, R. L. & Gladwin, C. H. (2005), 'Determinants of food security in Sothern Ethiopia at household level', Agricultural Economics Journal 33, 351-63.
5. Haque, S. A. (2006), 'Salinity problems and crop production in coastal regions of Bangladesh', Pakistan Journal of Botany 38 (5), 1359-65.
6. Kidane, H., Alemu, Z. G., and Kundhlande, G. (2005), 'Causes of household food security in Koredegaga Peasant Association, Oromiya Zone, Ethiopia', Agricultural Economics Journal 4, 543-60.
7. Mannaf, M. (2012), "An economic study on maize production and its impact on food security in selected areas of Bogra district", MS Ag Econ thesis, Bangladesh Agricultural University, Mymensingh.
8. Nasrin, M. (2011), 'Land tenure system and food security in some selected areas of Mymensingh district', MS Ag Econ thesis, Bangladesh Agricultural University, Mymensingh.
9. Shaha, K.K. (1995), Economics of sunflower and soybean production in a selected area of Bangladesh', MS Ag. Econ. thesis, Bangladesh Agricultural University, Mymensingh.

Appendix Table 1
Activity Budgets: Per Hectare T. Aman Rice Production

Items of returns /costs	Total quantity/ha	Per unit price (Tk)	Returns/Costs (Tk/ha)	% of total
A. Gross Returns				
Main product (Rice)	3046 kg	17.00	51,782.00	92.07
By-product (Straw)	n.a	-	4456.00	7.92
Total returns	-	-	56,238.00	100
B. Gross Costs				
C. Variable Costs				
Seedlings	n.a	-	3627.00	10.28
Power tiller	3 times	8/decimal	5928.00	16.81
Human labour	69 Man-day	300/Man-day	20,700.00	58.69
Urea	92 kg	20.00/kg	1840.00	5.22
TSP	57 kg	22.00/kg	1254.00	3.56
MOP	16 kg	16.00/kg	256.00	0.73
Fertilizers cost	-	-	3350.00	9.50
Insecticides	n.a	-	1087.00	3.08
Total	-	-	34,692.00	98.36
D. Fixed Costs				
Interest on OC	-	@10%	578.00	1.64
Total	-	-	578.00	1.64
E. Total costs	-	-	35,270.00	100.00
F. Gross Margin (A - C)		-	21,546.00	-
G. **Net Return** (A - E)		-	20,968.00	-

Source: *Adapted from Afsar (2013, p. 63).*

Appendix Table 2
Activity Budgets: Per Hectare Sesame Production

Items of return/cost	Total quantity/ha	Per unit price (Tk)	Returns/costs (Tk/ha)	% of total
A. Gross Returns				
Yield	952 kg	44.00	41,888.00	100
B. Gross Costs				
C. Variable Costs				
Seed	11 kg	54/kg	594.00	2.53
Power tiller	3 times	8/decimal	5928.00	25.22
Human labour	55 Man-day	300/Man-day	16500.00	70.21
Fertilizers cost	-	-	-	-
Insecticides	-	-	-	-
Total	-	-	23,022.00	97.96
D. Fixed Costs				
Interest on OC	-	@10%	480.00	2.04
Total	-	-	480.00	2.04
E. Total costs	-	-	23,502.00	100.00
F. Gross Margin (A - C)		-	18,866.00	-
G. Net Return		-	18,386.00	-

Source: *Adapted from Afsar (2013, p. 64).*

Appendix Table 3
Activity Budgets: Per Hectare Sunflower Production

Items of costs/ returns	Total quantity/ha	Per unit price (Tk)	Costs/returns (Tk/ha)	% of total
A. Gross Returns				
Main product	1957 kg	51.00	99,807.00	96.43
By-product	n.a	-	3694.00	3.57
Total returns	-	-	103,501.00	100
B. Gross Costs				
C. Variable Costs				
Seed	10 kg	1060.00/ kg	10,600.00	21.60
Power tiller	3 times	8/decimal	5928.00	12.08
Human labour	75 Man-day	300/ Man-day	22500.00	45.84
Urea	124 kg	20.00/kg	2480.00	5.05
TSP	106 kg	22.00/kg	2332.00	4.75
MOP	56 kg	15.00/kg	840.00	1.71
Gypsum	-	-	-	
Fertilizers cost	-	-	5652.00	11.51
Irrigation		-	2465.00	5.02
Insecticides	n.a	-	1134.00	2.31
Total	-	-	48,279.00	98.36
D. Fixed Costs				
Interest on OC	-	@10%	805.00	1.64
Total	-	-	805.00	1.64
E. Total costs	-	-	49,084.00	100.00
F. Gross Margin (A - C)		-	55,222.00	-
G. Net Return		-	54,417.00	

Source: *Adapted from Afsar (2013, p. 64).*

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 127-138
Bangladesh Economic Association
(ISSN 2227-3182)

Abnormal Population Growth and Its Effects on Agricultural Resource Management: Focusing the Global Situation with a Micro-level Example

BIKASH CHANDRA GHOSH*
MD. ELIAS HOSSAIN**

Abstract *Every year at least 10 million hectares of arable land are eroded throughout the world and consequently for such a loss, a huge amount of replacement is beaded from forests and other sources for agriculture and human settlement. In the meantime, world population exceeded 6 billion in the year 1999, and the projected data indicates that it is going to be almost 9 billion within the next 40 years. For that reason, demographers and environmentalists have highlighted that the main challenge for environmental management throughout the world today is to determine our planet's capacity to sustain such a huge amount of burgeoning human population. This paper assesses specifically the impact of growing population on agricultural resources around the world. To exemplify such a trend of agricultural land use, the paper incorporates a detailed example from an ethnographic case study on indigenous land-use practices and the experiences associated with modern cultivation for adapting to adverse situations caused by severe impact of a growing population in agriculture sector in rural Bangladesh.*

Keywords: *Growing Population, Agricultural Resource Management, Impact in Global Situation.*

1. Introduction

In the last few decades, there has been great concern over the issue of natural resource management in the global context. People are very much aware that the supply of

* Lecturer, Department of Economics, Pabna University of Science & Technology, Pabna-6600
** Professor, Department of Economics, Rajshahi University, Rajshahi-6205

various non-renewable natural resources on this planet is shrinking rapidly due to over-exhaustion and enhancement of resource appropriation. There has been rapid transformation of the world's natural landscape to agriculture, which indicates that such use of natural resources will soon exceed its carrying capacity by causing an irreversible damage to its natural ecosystem. While land use practices often vary greatly across the world, the ultimate purpose usually remains the same, which is to extract the natural resources for instant social needs, knowing clearly its severe impact on the environment. In the meantime, the world population has increased from 3 billion in 1959 to 6 billion in 1999, which took only 40 years for it to double. The US Census Bureau of the International Data Base also projected and mentioned that this number will be 9 billion in the year 2044, an increase of 50% within a span of 45 years (US Census Bureau, 2010). Accordingly, the demographers and environmentalists have posed a concern; the main challenge for the global environment is to determine our planet's capacity to sustain such a huge number of growing populations. In this context, the carrying capacity of the planet may further be measured by calculating the per capita requirement of food and nutrition subsistence. To provide adequate food subsistence to the people living with diverse diet will require at least 0.5 hectare of arable land per person (Lal & Steward, 1990), but at this time we have only 0.27 hectare per capita land available to us, which will drastically be reduced to 0.14 hectare per person within the next 40 years due to loss of land caused by population pressure (Pimentel, 1993; Pimentel, Harman, Pacenza, Pecarsky, Pimentel. M., 1994; Pimentel, Harvey, Resosudarno, Sincliar, Keuz, McNair, Crist, Shpritz, Fitton, Saffouri, and Blair, 1995; Pimentel, 1997). In his book titled 'World Soil Erosion and Conservation' published in the year 1993, David Pimentel mentioned that per capita shortage in the availability of land has remained the major reason for severe food shortage and malnutrition in many parts of the world. The environmental depression is further intensified due to soil erosion in agricultural areas where 75 billion of metric tons of soil are demolished from the fields through wind and water, mostly affecting the cultivatable land (Myers, 1993). Furthermore, deforestation and desertification have been occurring in the last two decades causing the human beings to be more vulnerable to shortages of land (Skole & Tucker, 1997). In the process of deforestation and desertification, more forest areas are converted to farming activities (Global estimates of tropical deforestation range from 69,000 km in 1980 to 10000-16500 km in the late 1980s [Devid & Tucker, 1997]).

Based on the informative introduction, the main purpose of this paper is to analyze the effect of population growth on available agricultural resources around the world, which creates pressure on indigenous and sustainable agricultural management.

From the methodological point of view, researchers used both primary and secondary data where the secondary sources of data from global perspective have conceptualized an analytic-descriptive framework for explaining the world's demographic situation, contextualizing its impact on environmental resource management. In consonance with the above dimension, researchers have incorporated an ethnographic documentation at the micro-level, showing the situation at the village level. As a matter of fact, this is an important test on the effectiveness and accuracy of what has been stated at the macro perspective in the global context and an ethnographic brief in this context is proving our statement at the field level.

2. Equation of Population Growth and Its Impact around the World

Until about 18th century, the world population was kept under check through war, famines and diseases. As a result it did not pose any serious threat for the people around the world until that time. The overall statistics on world population exhibits that it remained at 1 billion until 1830, and it took 100 years to double the population to 2 billion in the year 1930. But subsequently, within a range of 30 years later in 1960, the cumulative growth of population stood at 3 billion worldwide. It took only another 15 years in 1975 to increase the total population of the world to 4 billion. To explain more analytically, the causative factor for a lower number of population growth prior to 1930 was not for its lower birth, but because of the high rate of mortality due to some severe and uncontrollable epidemics which caused a huge number of world population to perish at that time. The mortality rate in those days further increased due to conditions like famines, accidents, etc., which reduced human population even though there was high fertility. It is clear from the above statistics that within a stipulated period of only 45 years from 1930 to 1975 the population of the world had simply doubled. In this continuous process, twelve years later in 1987, the population of the world reached 5 billion. In the year 1999, it became 6 billion which further increased to 6.8 billion in the year 2009 (United Nations Population Reference Bureau, 2009). World population is expected to grow to 8.9 billion in 2050, and much of the demographic change up to this period will occur in the less developed nations.

Although the overall population growth rate throughout the world had decreased considerably during the latter part of the last century, the population growth rate in general remained consistently high in many poor and underdeveloped countries. During the period till 1960, the population growth rate throughout the world peaked at 2.4% per year which later fell to 1.9% during 1999, meaning that population increased by 87 million every year. Extrapolating on such trend of

Table 1 : Global Population Situation

Year	Population (in Billion)	Year	Total Fertility Rate
1830	1	1969	6
1901	1.4	1999	3
1930	2	Population Growth Rate	
1960	3	1969	2.4
1975	4	1999	1.9
1987	5		
1999	6	World Population Projected for 2050: 9.1 billion	

Source: *Prema Ramachardaran et al, 2008; UNDP 2009.*

lower fertility rate, UNDP's projected data clearly indicate that the world population will reach 9.1 billion by 2050 (Wright, 2008; UNDP, 2009). Rising population has already been a problem for many poor and developing nations of the world. For instance, the population in India, which is approximately 1.15 billion, inhabits an area of 3,287,240 sq. km. Its current growth rate is 1.3% per year which will double in the next 37 years (Pimentel et al, 1995). Similarly, China has 1.27 billion people with a growth rate of 1.1% which is the optimum desirable rate of the percent size (Qu & Li, 1992). Despite the government's effort to reduce the growth rate by allowing only one child per couple, the population of China has continued to increase every year. One of the poorest countries of the world, Bangladesh has about 153 million people living in a surface area of 1,47,570 sq. km. In 1930, its total population was only 35.5 million which has now increased to more than four times to make it 153.50 million in 2008; Bangladesh now faces a daunting challenge to feed its population where at least half of them are living in food based poverty level (Cuffaro, 1997; Karim, 2011).

3. Population Pressure on Land and Agricultural Resources: Global Context

Population increase in many parts of the world has consequential effect on agricultural resource because an excessive growth of population can drastically minimize agricultural land throughout the world. It is reported that agricultural land, which extracts food and cereals, contains only 12% of the total land area of the planet, which does not seem to be sufficient in terms of covering the subsistence of such a huge incumbent population. Of the remaining land 24% are arid grass land which is used for pasturing and grazing purposes, and another 30% is covered by forest necessary to protect the environment from greenhouse effect and other climatological imbalances. The remaining 34% of the total land of the planet is fully unusable for any crop production as they are stony, too steepy or are exposed to extremely dry, cold and wet atmospheric conditions (Buringh, 1989). These lands are simply geologically infertile, unusable for pastures as grass land, and climatically unsuitable for crop production (Pimentel, 1989).

Thus, it becomes logical that when population grows at an unlimited rate, it obviously puts pressure on our marginally available 12% of useable agricultural land, the supply of which is also shrinking day by day. An extreme growth of population also squeezes the per capita availability of cultivable land. Based on evidence, it is calculated that at present we require 0.5 hectare per capita crop land as a minimal requirement to sustain a proper diet and nutrition. But due to continuous population growth and also rapid land degradation, the availability of per capita land is reduced to an extreme point day by day (Leach, 1995). In many Third World countries, it is far below the global average, putting people under serious food shortage and effectual causation of poverty and hunger.

We know that land and its terrestrial environment is essentially an important natural resource which provides 99% of humans' food requirement (Pimentel & Pimentel, 1996). Thus, logically it is quite likely that when this land is under serious threat due to population growth, farmers need to use the same land repeatedly through intensive multi-cropping production. When farmers go for intensive cultivation, they have to utilize mechanized farming and make an abrupt shift from their traditional indigenous farming system. The introduction of mechanized farming provides a sharp increase of crop production, which is essential to support a growing population. Traditional subsistence farming in Asia and Africa in the past involved the rotating cultivation or mono-cropping, keeping the land fallow for some time, which as a matter of fact allowed the land to be revitalized and regain its nutrients. But with the increase of population, people put continuous pressure on land, without allowing them any time off. The resulting consequence is the deterioration of the soil, which keeps the land fully dependent on chemical fertilizer and uncontrolled irrigation. Therefore, peasants moving towards mechanized farming no longer depend on seasonal rain and also, at the same time, are totally dislodged from indigenous farming mechanisms. Due to mechanized farming, crop production increases, and yet a complementary notion develops when people usually care less about reducing the population.

4. Demographic Impact on Agricultural Land Use: A Micro-Level Example from an Ethnographic Research

In this part the researchers present an ethnographic documentation on two villages in Bangladesh. Dhonjoypara and Gopalhati are both agricultural communities located in the same physiographic and environmental setting. They belong to Puthia union (A union usually comprises of 6-15 villages) of Rajshahi District in the north-western part of Bangladesh. Physiographically, Puthia and these villages lie on the outer margin of the riparian tract which is about eight miles from the left bank of the Padma River. The mean temperature for Puthia and the study villages increases from 63^0 in January to $>85^0$ in the summer months. Of the yearly rainfall of about 56 inches, no less than 50 inches fall in the rainy season. Compared to other parts of the country, the rainfall of Puthia villages is far less, which speaks of the necessity for irrigation of its land.

On the basis of surface level, there are three types of land in Puthia: (1) *Daira,* also known as *bhiti* land, meaning land for homestead or the elevated land above flood-level; (2) *Mathan* or the flat fields of intermediate level, which are partially flooded during the rainy season; and (3) *Layal* or the low-lying land which is completely flooded during the rainy season. These diverse soils of the villages provide them with diversified cropping pattern.

5. Settlement Trends: Agricultural Land use and the Population Dynamics in the Villages

Researchers have examined the settlement trend, land use pattern and the population dynamics in Dhononjoypara and Gopalhati to provide data at the micro-level investigation. Information about village settlement is very significant as it gives us an indication about the population pressure, which compels people in the villages to convert their agricultural land to homesteads. Information about village settlement prior to 1850 is not available. According to the first village revenue survey of 1850, Dhononjoypara contained 205 acres of land while Gopalhati had 309 acres of land in its *mouza.* The village revenue survey of 1850 indicated that mouza Dhononjoypara at that time had only five households occupying in total 9 acres for homesteads. The amount of cultivable land in Dhononjoypara was 1990 acres and the remaining 6 acres was waste and uncultivable. On the other hand, Gopalhati had 14 households having 25 acres for homesteads; the amount of cultivable land was 368 acres (Table 2).

The amount of cultivable land was 190 acres and the remaining 6 acres was waste and uncultivable. On the other hand, Gopalhati had 14 households having 25 acres for homesteads and the amount of cultivable land was 368 acres.

The census reports of 1951 and 1961 provide information on population, households and literacy but do not give any information on settlement pattern, thereby making it impossible to analyze in detail the changes over time. However,

Table 2 : Land-use pattern for villages Dhononjoypara and Gopalhati Since 1850 (acres)

	Dhononjoypara				Gopalhati		
Census Year	Land used for Settlement	Land Used for Cultivation	Waste and Uncultivable Land	Total	Land used for Settlement	Land Used for Cultivation	Total
1850	9	190	6	205	25	369	393
1968	58	152	-	210	99	293	392
1974	No information	No Information	No informatior	210	No Information	No information	399

Sources: *First Village Revenue Survey, 1850; Revisional Settlement Survey, 1968.*

the revisional settlement survey of 1968, which came out in 1978 filled the vacuum in this regard, and the Census Report of 1974 provided gross data on the total amount of land available in each village. According to the Revisional Settlement Survey (1968), *mouza* Dhononjoypara had 210 acres of total land of which 152 acres were cultivated. In Gopalhati, there were 392 acres of total land, of which 99 acres had been used as settlement and the remaining 293 acres were agricultural land. It may be inferred from the Revisional Settlement data that there has been a tremendous increase of land for settlement in both villages since 1850. The reason is obviously the increase in population.

To have a clear picture of population growth in Dhononjoypara and Gopalhati, a demographic view of the villages since 1951 to present time is shown in Table 3. To enquire about the population transition of the villages for the past century it is necessary to know the population dynamics of Puthia Union and Puthia Upazila as a whole. Census recording in the sub-continent of Bangladesh-India and Pakistan began as late as 1872. But there is no information on population at the village level, nor does the Village Census of 1901 dealt specifically with village statistics. It was simply a camouflage in the name of Village Census. In fact, population statistics at the village level only came into existence in 1951.

The reported census of 1872 and 1901 produced data on the *thana* (i.e., present upazila) level which indicate that there were decades of declining population in Puthia Upazila. The Bengal District Gazetters-Rajshahi-1916 (O’Malley, 1916) indicate that the population of Puthia and adjoining Upazilas (i.e., Bagmara, Mohanpur, Paba & Charghat) declined tremendously between 1872 and 1891 due to prevalence of malaria, smallpox, and cholera together with water-hyacinth which blocked the water channels. This caused a 15.01% decrease of population (1976, p.48). Through 1901, Puthia and the adjoining upazilas sustained a loss of population by a decrease of 12.08 % (O’Malley, 1916). Many people died in this swampy water-logged area and others migrated to the comparatively healthier and

Table 3 : Demographic data for villages Dhononjoypara and Gopalhati (1951-2012)

	Dhononjoypara					Gopalhati				
Year	Number of HH	Total Population	Male	Female	Literacy Rate	Number of HH	Total Population	Male	Female	Literacy Rate
1951	No data	350	No data	No data	No data	90	380	No data	No data	No data
1961	72	371	195	176	15.36	93	513	264	249	11.11
1974	62	348	164	84	20.69	151	959	478	481	11.57
1985	105	660	345	316	23.60	196	1207	631	576	14.17
2013	199	915	471	444	47.60	299	1964	997	967	46.50

Sources: *Census Reports 1957, 1961, 1974; Karim, 1990; Field Report, 2013* more prosperous areas (Naogaon & Panchupur, n.d.) of Rajshahi Region (O'Malley, 1916). Nelson (1923) reported that the population of Puthia decreased by 44% between 1872 to 1912. This declining population trend for Puthia continued till 1951 due to a large emigration of the Hindus to India during and after 1947 (Hossain *et al*., n. d.). From 1951 onwards, the population had again increased in Puthia Union, as it had for Dhononjoypara and Gopalhati. The increase of population for Puthia Union between 1951 and 1960 is 32.2% (Hossain *et al.,* n. d.). This growth rate has been mostly due to increasing birth rates. Side by side with the population growth, we find that there had occurred a tremendous loss of the agricultural land in the villages of Dhononjoypara and Gopalhati.

6. Findings and Discussions

Based on the above discussion, it is observed that since the beginning of human history, global population increased tremendously putting the people on the earth in enormous problems and economic hardship. It has been evidenced that when the world population was 1 billion until 1830, it took only 100 years to double the number to 2 billion in 1930. We found that within a span of 45 years, this number doubled again to 4 billion in 1975. There was an addition of another two billion people by the end of the Twentieth century to raise the world population to 6 billion in 1999. Thus it has been observed that with the passing of time population doubled in lesser and lesser time period. Such increase of population requires more and more land for settlement and habitation having a direct impact on natural resources. It has been calculated that overpopulation is the prime reason for reducing per capita availability of land. To substantiate this statement, the paper has incorporated an ethnographic documentation of two villages from Bangladesh where it has been evidenced that demographic pressure has resulted in the transformation of agricultural land. Based on the data, it has been found that this loss of land in the villages Dhononjoypara was 18% and for Gopalhati, it was 19%. It is thus indicative that population increase puts heavy pressure on cropland when the people in the rural areas have been compelled to divert their farming land toward settlement and habitation.

7. Conclusion and Recommendations

Rapid population growth has been identified as the single most important factor for environmental degradation, which causes extreme poverty and also deterioration of living standard in many nations of the world. It causes tremendous transformation of the world's natural landscape to agriculture. In our paper, we have documented the gradual incremental rate of population growth in the global context, and also at the same time, we have provided ethnographic documentation of the pattern of such growth at the village level. It has been argued by a few scholars (e.g., Buchholz, 1993; Karim, 2010) that the future of food security and land protection entirely depends on the control of and restriction on births than emphasis on unusual use of chemical fertilizer to boost agricultural production. There is argument that it is more humane and ethical to implement family planning programme to keep the population at the lowest level than allow people to be victims of starvation. To allow the increase in population is nothing but to cause starvation, health problems, increasing unemployment and finally the destruction of the environment. This is particularly true for some Third World countries like India, Pakistan, Bangladesh, Ethiopia, Indonesia and Nigeria where there is rapid increase of population among the lower-income and poorer sections. It is assumed that family planning programme does not work properly in these countries at the rural level. Governments and the NGOs in many of these countries try to popularize family planning programme among the wealthy, rich and educated segments of society who are nevertheless are quite aware of the situation (Karim, 2010). We must remember that when population increases, much cropland is taken for urban and rural habitation. In order to feed many mouths, farmers have to use excessive fertilizers and pesticides which eventually destroy the fertility of the soil and also at the same time, negatively affect human health. It has been proven from the ethnographic examples given in this paper that there has been a tremendous shrinking of agricultural land in the two villages of Bangladesh within the span of one hundred years. This is particularly true for Bangladesh as well as for other developing nations like India, China and Indonesia, which have all the potential of development but often lag behind because of their demographic pressure and low man-land achievement (Kumar, 2000).

Based on the above discussion, we conclude by presenting a very simple formula below for the peasants around the world in regard to their agricultural land-use pattern. The suggestion is that each and every nation around the world should formulate their own policies with a target to bring the population growth at a replacement level, and simultaneously they should invent some techniques to solve the food crisis throughout the world.

References

1. Buchholz, R. A. (1993). *Principles of Environmental Management.* New Jersey: Prentice-Hall.
2. Buringh, P. (1989). *Availability of agriculture land for crop and livestock Production.* In D. Pimentel & C. W. Hall (Eds.), *Food and Natural Resources* (pp. 69-83). San Diego: Academic Press.
3. Cuffaro, N. (1997). Population Growth and Agriculture in Poor Countries: A Review of Theoretical Issues and Empirical Evidences. *World Development,* 25(7), 1151-1163. http://dx.doi.org/10.1016/S0305-750X(97)00025-9
4. Government of Pakistan. (1951). *Census of East Pakistan.* Karachi: Government Press.
5. Government of the People's Republic of Bangladesh. (1974). *Village Census* (1974). Dhaka: Bureau of Statistics.
6. Hossain et al. (n. d.). *The Pattern of a Peasant Economy, Puthia-A Case Study*. Rajshahi: Socio-Economic Survey Project, Rajshahi University.
7. Karim, A. H. M. Z. (1990). *The Pattern of Rural leadership in an Agrarian Society: A Case Study of the Changing Power Structure in Bangladesh.* New Delhi: Northern Book Center.
8. Karim, A. H. M. Z. (2011). Agro-based Food Production System in Bangladesh: A Socio- Demographic Impact Assessment from Asian Examples. *The Social Sciences,* 6(6), 473-479.
9. Lal, R. (1989). Land Degradation and its Impact on Food and other Resources. In D. Piementel (Ed.), *Food and Natural Resources.* San Diego: Academic press.
10. Leach. (1995). *Global Land and Food in the 21st Century.* Stockholm: International Institute for Environmental Technology and Management.
11. Myers, N. (1993). *Gaia: An Atlas of Planet Management.* Garden City: Anchor and Doubleday.
12. Nelson, W. H. (1923). *Final Report on the Survey and Settlement Operation in the District of Rajshahi: 1912-1922.* Calcutta: The Bengal Secretariat Book Department.
13. O'Malley, L. S. S. (1916). *Bengal District Gazetteers: Rajshahi.* Calcutta: The Bengal secretariat press.
14. Piementel et al. (1994). Natural Resources and Optimum Human Population. *Population and Environment,* 15, 1117-1123. http://dx.doi.org/10.1126/science.267.5201.1117

15. Piementel et al. (1996). *Food Energy and Society.* Colorado: University Press of Colorado.

16. Pimental, D. (1997). Environmental and Economic costs of Soil. In U. Tim (Ed.), *Environmental management: readings and case studies.* Oxford: Blackwell Publishers.

17. Pimentel, D. (1989). Ecological Systems, natural resources, and food supplies. In D. Pimentel & C. W. Hall (Eds.), *Food and Natural Resources* (pp. 1-29). San Diego: Academic Press.

18. Pimentel, D. (1993). *World Soil Erosion and Conservation.* Cambridge: Cambridge University Press. http://dx.doi.org/10.1017/CBO9780511735394.

19. Qu, G., & Li, J. (1992). *Population and Environment in China.* Beijing: China Environmental Science Press (In Chinese), referred in Pimentel (1994).

20. Siddique, A. (1976). *Bangladesh District Gazetter-Rajshahi.* Dhaka: Bangladesh Government Press.

21. UNDP (United Nations Development Program). (2009). *Human Development report 2009.* New York: Oxford University Press.

22. Wright, R. (2008). *Environmental Science: Toward a Sustainable Future.* NJ: Pearson: Prentice Hall.

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 139-150
Bangladesh Economic Association
(ISSN 2227-3182)

Climatic Variability, Agricultural Transformation and Food Security in the North-Western Bangladesh

A.N.K.Noman*
Kazi Julfikar Ali**

Abstract *The Process of transformation of agriculture in the Northern Bangladesh has been going on for more than a decade. The nature of transformation could be characterized as the transformation of rice fields into mango orchards. This is changing the very basic characteristics of the socio-economic activities as well as the life style of the people in this area. There are several reasons which are guiding the transformation process from behind. Among different reasons, economic factor was found to be the principal reason. The environmental factors like fall in rainfall, change in the pattern of rainfall, fall in ground water level, rise in temperature, increase in pest attack etc. have significant indirect influence on transformation. These climatic factors are actually influencing transformation by influencing cost-benefit scenario of mango and rice cultivation. In that regard, a survey was conducted in Nawabgonj sadar Upazilla under Nawabgonj district in March 2014 and data were analyzed. In this study climatic variability is defined in terms of variability in rainfall, transformation is defined in terms of the ratio of mango orchard to total cultivable area, and food security is defined in terms of food production or availability. To establish functional relationship among the variables a regression was estimated and results presented. The results support the hypothesis that transformation is influenced by climatic variability and return from cultivation. This transformation is permanently shifting crop land to orchards causing a sharp reduction of cultivable land which in turn is reducing food production. It is important to note that this region is one of the major contributors to national food supply and this tendency of*

* Professor, Department of Economics, University of Rajshahi.
** Assistant Professor, Department of Economics, University of Rajshahi.

transformation may increase the vulnerability of the already weak national food security situation. This needs urgent policy attention and intervention by the government.

Key words: *Climatic variability, Agricultural transformation, Food Security, Northern Bangladesh.*

1. Introduction and background information

Bangladesh economy has been growing consistently over the last three decades and the growth has accelerated during the last decade. One of the major contributors behind the growth is the consistent performance of the agriculture sector. Again the performance of agriculture sector is dominated by the performance of the crop sector.

Bangladesh is a country with a population of almost 160 million, increasing at a rate of 1.3 percent, adding about 2 million labour to the existing 72 million every year. Agriculture is still the principal economic activity and the single largest contributor to GDP. It provides 45 percent of total national employment. If we only consider the rural economy, then agriculture alone provides employment for more than 70 percent of the rural labor force. Among the various agricultural products, rice is the main crop as well as the staple food of the country and the demand for rice is constantly rising in Bangladesh with nearly 2.3 million people being added each year to its population. Bangladesh is still dependent on food import and the pressure on import is on a rise in recent years. To feed the growing number of population is one of the big challenges this country is facing now. The cultivable land is shrinking alarmingly in the country. Urbanization, building of settlement and river erosion are the main factors responsible for loss of productive agricultural land. Bangladesh also faces production constraints due to a number of unexpected calamities such as flood, drought, erratic rainfall, lack of irrigation facilities, river erosion and salinity of soils etc.

Moreover, one of the most grievous challenges that Bangladesh agriculture will have to face is the adverse impact of climate change (CC). It is projected that the production of rice will be reduced by more than eight percent by 2050 because of the change in temperature. Predicted sea level rise is likely to inundate a huge land of the coastal belt. Flood, drought and cyclone are expected to be more frequent and severe that may toll a serious damage in the agriculture sector. So, shrinking of agricultural land as well as production, adverse impact of CC compounded with a large population will put the country's food and income security at a great risk.

In addition to that, transformation of paddy land to other uses is another most important factor that is undermining the cereal production. Recently, the north-western (NW) part of the country is witnessing a rapid transformation within agricultural sector, that is transformation of paddy field into mango orchard. This region is historically a surplus food producing area and one of the biggest contributors to national food supply. Since Bangladesh is experiencing a continued annual shortage of grain, transformation of agricultural land to other uses will definitely have a negative impact on total cereal production as well as on the economy. It is going to put Bangladesh to a great challenge to maintain its food-population balance. The only way out for Bangladesh is to import more and more cereals from the international market. But, the international food supply is also under constant threat at the changing climatic condition and growing number of population worldwide.

Moreover, the concern is not all about the production of cereals but also the livelihood system and food security of the majority of the population. Since half of the total labor force depends solely on agriculture, any change in agricultural sector has substantial impact on their income and employment situation. This agricultural labor force is also the poorest and most vulnerable section of the country. There are a lot of inherent factors associated with their poverty and livelihood vulnerability. Such vulnerability arises mainly from the unemployment, income deficit, and instability of agricultural production. These people have less ability to recover from any disaster. No doubt, transformation of agriculture compounded with the above stated factors will worsen the poverty situation in the country. Hence, a core concern for Bangladesh is to sustain her rice productivity while protecting food security and employment for the majority of the population.

So the principal focus of the study is to identify the nature and causes of agricultural transformation and to assess the impact of transformation on food production and accessibility i.e. the major components of food security.

There are very few studies available on this issue. The previous studies on this issue were conducted by the first author himself where the methodological approach was different. In this study more disaggregated data are used to pinpoint the relationship among the variables encouraging the process of transformation. This relationship is estimated with the help of regression function estimation. This adds more insight to the studies on the process of transformation. In this study the variability of rainfall is considered for the months of June to August, the sowing season for the principal crop, transplanted Aman. Usually the other studies consider variability of rainfall or average rainfall for the year. This does not reflect the true scenario on this issue.

2. Objectives of the study

The principal purpose of the study is to highlight the various perspectives of causes and possible impact of transformation of paddy field to mango farming. Therefore, the study focuses on the following key issues:

i) Investigate the nature, type and causes of transformation of agriculture; and

ii) Assess the impact of agricultural transformation, especially the mango farming on production of food grain.

3. Conceptual framework of the study

Agriculture depends on nature, and the production decisions are basically guided by profitability. The farmers behave rationally and take decisions accordingly. The change in climatic factors influences the production activities by pushing the cost of production up and net revenue down. The tenants are less willing to share the produce according to traditional practice. So it is no longer profitable for the owners to rent their land to the tenants. Again the net return from mango orchard is very high in comparison to that of crop production. The risk factor for crop production is also higher. So the land owners and the farmers are rapidly transforming their land from cereal production to mango orchard. As a consequence, cultivable land is shrinking fast and posing a threat to food security.

4. Methodology

4.1 The data

For purpose of the study, the relevant micro-level data were collected from Upazilla agricultural offices and also directly from the farmers and other stakeholders to identify the nature, causes and impact of transformation. The data related to both climatic variables as well as economic variables were collected to establish the relationship between agricultural transformation and climatic variability and net revenue.

Among the 16 northwestern districts, five districts namely, Rajshahi, Natore, Naogaon, Nawabgonj, and Dinajpur, where the intensity of transformation is higher, were taken under investigation. Two Upazillas from each district were selected for the study purpose. So the total number of Upazillas under investigation were 10. As part of the ongoing study some of the findings from Chapai Nawabgonj district are presented in this article.

4.2 The model

The collected data were analyzed using basic statistical techniques. In addition, a regression function is estimated showing the relationship between agricultural transformation and variability of rainfall and average net revenue of the cereals. The functional expression is as follows:

Where,

Q = agricultural transformation to mango orchard per hector

X_1 = variability of rainfall per year

X_2 = average net revenue of cereal crops per hector

= error term

A priori expectation about the sign of the coefficient is . The error term is assumed to be random and serially independent having zero mean with finite variance. The empirical model is estimated by OLS method. Diagnostic tests for autocorrelation and multicollinearity were carried out to improve the quality of estimation.

4.3 The basic features of the study area

This study area is the part of High Ganges River Floodplain. The area is predominantly highland and medium highland. There is an overall pattern of olive-brown silt loams and silty clay loams on the upper parts of floodplain ridges and dark grey, mottled brown, mainly clay soils on ridge sites and in basins. Most ridge soils are calcareous throughout. General soil types predominantly include Calcareous Dark Grey Floodplain soils and Calcareous Brown Floodplain soils. Organic matter content in brown ridge soils is low and higher in dark grey soils. Soils are slightly alkaline in reaction. General fertility level is low.

5. Climatic factors

5.1 Sowing and harvesting periods

Table 1 shows the sowing and harvesting time for major rice crop in Bangladesh. Aman is cultivated in about 50 percent of the total cultivable land whereas Boro covers more than 40 percent of the total cultivable area (GOB, 2011). The sowing period for HYV transplant Aman is late June to mid August. During this period water requirement is the highest but the rainfall pattern shows that the variability of rainfall is also very high during this period (Table 3). During boro cultivation period the rainfall is seldom seen in the area. So it is totally dependent on underground irrigation water. The irrigation statistics shows that the area under irrigation was not expanding anymore during the last decade, rather the command area under the DTWs and STWs are shrinking gradually.

Table 1 : Sowing and Harvesting Period of Major Rice Crops

Principal Crop	Time of Sowing/Transplanting	Time of Harvesting
1	2	3
Aman HYV Transplant	Late June to Mid August	December to early January
Boro HYV and Hybrid	December to Mid February	Mid April to June

Source: *BBS, 2011*

Table 2 shows that the number of DTWs installed in the area increased from 192 in 2005 to 219 in 2013, while the area irrigated under these DTWs fell from 4640 hectares to 3495 hectares in 2013. So not only the command area is shrinking but the total area under DTW irrigation has registered a decline. As a consequence, the area under Aman and Boro cultivation as well as the production has marked a

Table 2 : Number of machines and irrigated areas under different irrigation methods 2005 - 2013

	DTW		STW		LLP		Total
Year	number	area	number	area	number	area	area
2005	192	4640	2956	14867	294	3230	22737
2006	197	3834	3233	13281	294	4795	21910
2007	197	4370	3443	13493	422	4763	22626
2008	208	5226	3424	9551	315	3963	18740
2009	219	2960	3554	11560	311	4413	18933
2010	220	4790	3528	10665	256	4565	20020
2011	225	4870	3528	11731	256	3820	20421
2012	219	4875	3420	11550	250	3800	20225
2013	219	3495	3205	11150	237	3415	18060

Source: *DAE, Chapainawabgonj sadar Upazilla, 2014*

sharp decline (Table 2). The lands where these crops are cultivated are also suitable for mango cultivation. So shrinkage of these areas is witnessing the process of transformation from rice cultivation to mango orchards.

Usual practice for Aman cultivation is that it is basically a rain fed crop. So the cost of irrigation for Aman is always low. But because of the increase in the variability of rainfall during the sowing season and afterward, the cost of irrigation for Aman is how registering an upward trend and has already pushed the cost of production up. As a consequence, the net revenue is showing a falling trend for this crop. This is also true for Boro. Because of less availability of underground water the cost of irrigation is also increasing and as a consequence net revenue is showing a decline. This fall in revenue is prompting the process of transformation.

Monthly rainfall, average yearly rainfall and the log variability of three months and twelve months are presented in Table 3. The findings show that the monthly variability for the peak three months namely in June, July and August are much higher than the yearly variability. The water requirement during the sowing

Table 3 : Monthly rainfall in Nawabgonj district from 1999 to 2013 (millimeters)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	V_In_3	V_In_12
1999	0	0	0	9	144	478	364	425	388	60	53	0	8.09	10.53
2000	3	48	16	56	304	264	200	103	826	14	0	0	8.79	10.94
2001	0	0	0	3	235	144	186	124	203	228	0	0	6.91	9.25
2002	0	0	0	116	90	96	205	195	233	59	9	0	8.20	8.95
2003	0	42	53	5	25	303	247	69	118	177	0	0	9.61	9.28
2004	26	0	0	65	117	290	278	66	199	387	0	0	9.67	9.83
2005	18	0	100	21	83	46	409	397	56	217	0	0	10.66	10.01
2006	0	0	19	38	353	246	191	203	165	33	19	0	6.73	9.58
2007	0	41	5	5	112	282	827	258	240	0	0	0	11.55	10.97
2008	2.5	9	0	44	115	379	285	152	154	47	0	11	9.47	9.64
2009	0	11	14	18	201	208	210	216	248	47	5	0	2.85	9.32
2010	0	0	9	70	101	214	275	97	222	67	0	9	9.01	9.17
2011	0	0	62	82	149	771	180	347	209	32	0	0	11.44	10.81
2012	10	0	2	62	25	98	208	154	228	20	0	0	8.01	8.88
2013	0	11	0	59	116	109	180							

Source: *DAE, Chapainawabgonj sadar upazilla, 2014*

season is high and any variability during this period hampers the production activities badly. It may also significantly push the cost of production up.

6. Economic factors

Transformation of rice fields into mango orchards are presented in Table 4. An increase of 750 percent during last eight years is seen in column 4 and 5. In 2005

Table 4 : Change in mango and rice area in Nawabgonj sadar upazilla 2014

Year	Total Cultiva ble Area (hectare	Orchards (hectare	Crop land under plantation (hectare)	% increase	Total Orchard (hectare	% increa se	Orchards as % of total Cultivable Area
1	2	3	4	5	6	7	8
2005	34100	2188	200		2388		7%
2013	31500	2600	1700	750	4300	80	14%

Source: *UAO Chapainawabgonj, 2014*

total mango orchards was only seven percent of total cultivable land which increased to 14 percent in 2013.

Table 5 shows net revenue from mango orchard per hectare. A mango orchard may remain productive for more than a century. So as the trees grow older the production increases with the size of the trees. So the calculations of return are a little bit tricky. The above figures presented in Table 5 are the average minimum during normal years. The variations of production in off season and on seasons are also taken into consideration for the calculation. If we compare the net revenue from mango orchard with the average net revenue from cereal crops then it could be seen that the return from mango orchard is five to ten times higher than that of cereal crops.

Tenancy relationship has also a very important role to play to encourage the process of transformation. More than fifty percent of our land is cultivated under

Table 5 : Revenue from a mango orchard per hectare (1 hectare = 7.49 bigha)

Age of Orchard	Average number of Trees per hectare	Average production per tree (kg)	Production per hectare (kg)	Average wholesale price per kg	revenue per hectare	Cost per hectare	re he
1	2	3	4	5	6	7	
5-10 years	75	30	2250	35	78750	7500	7
10+ Years	75	135	10000	35	350000	25000	32

Source: *UAO Chapainawabgonj, 2014* sharecropping. With the increase in the cost of production the owners are getting less share of output from the tenants. So they are more willing to transform their land to orchards.

The change in the pattern of rainfall has increased the vulnerability of production. Irrigation cost has increased significantly. The average rainfall does not show much variability but it is not following any clear pattern, farmers are now becoming more dependent on irrigation water. The increase in the price of input as well as wage of the agricultural labours has pushed the cost of production up.

Table 6 : Total area and production of different rice crops from 2005-2013

	Aus		Aman		Boro	
Year	Area (hectare)	Production (MT)	Area (hectare)	Production (MT)	Area (hectare)	Production (MT)
2005	16655	25983	10450	28034	13730	50937
2006	16070	27300	10650	32758	12520	40690
2007	16170	30062	10450	29083	11560	41233
2008	17315	31540	10700	33017	11690	49299
2009	18195	31538	10750	28907	11620	46573
2010	17140	27365	10850	27007	11050	40756
2011	18250	39618	10910	32685	12565	50763
2012	18160	23666	10250	28060	12220	50703
2013	16050	31520	7500	21450	11250	46835

Source: *UAO Chapainawabgonj, 2014*

7. Empirical results

Table 7 shows the casual relation among the agricultural transformation, rainfall variability and net revenue of rice, wheat and maize production of Nawabgonj district. The coefficient of variability of rainfall is 0.003 and it is significant at 10 percent level. The results show that as variability of rainfall increases by 1 percent agricultural transformation from rice cultivation to mango orchards increases by 0.003 percent. The coefficient of net revenue is -0.079 and it is statistically significant at 1 percent level. The sign of the coefficient is also consistent with the theoretical relationship presented in the empirical model. The results show that as net revenue increases by 1 percent agricultural transformation decreases by 0.079

Table 7 : Causal relation among the agricultural transformation, climatic variable and net revenue of cereal crops

Variable	Coefficient	Standard error	T statistic	*P* value	Tolerance	VIF
Constant	0.689	0.098	7.054	0.00		
Variability of Rainfall	0.003	0.012	1.758	0.10	0.981	1.020
Net Revenue	-0.079	0.001	-6.413	0.00	0.981	1.020
R square	0.898					
Durbin – Watson test	1.057					

Source: *Own estimated result, 2014*

percent. Multicollinearity is tested by Variance inflation factor (VIF). The threshold value of VIF for testing the severity of multicollinearity is 5. The value of VIF in the table is less than 5, which means there is no multicollinearity problem in this model.

8. Conclusion

The data analysis results and the empirical estimations show that the process of transformation of rice field is influenced by both the climatic and economic factors. The data also indicates that a significant amount of cultivable land has already been transformed permanently into mango orchard. The consequence of transformation has already been felt in terms of rice production. Similar findings were obtained from a pilot study in Porsha Upazilla under Nawgoan district (Noman, 2011). The degree of transformation was found much higher in Porsha than that in Nawabgonj. Both of these areas are surplus crop producing areas and significant contributors to national food supply. It is observed that the production of the major crops in both of the areas is registering a decline. If the process of transformation continues in this manner, there is very high possibility that these areas will become net deficit area in crop production within a decade. This will pose a threat to national food security on the face of rising food demand both arising from increasing population and income. So it is high time to address the issue in a comprehensive national food security policy and act accordingly.

The study is only confined to the Nawabgonj district. So, the study did not provide the actual picture of the entire region. The quality of the study could be improved further by incorporating other areas. The pitfalls of regression like normality need to be addressed for achieving more reliable results. Another shortcoming of this study is that it did not analyze the time series Property like unit root test etc. because of the short span of the data series.

References

1. GOB (2011), Agricultural Statistics, Bangladesh Bureau of Statistics, Ministry of Planning, Government of Bangladesh.
2. Noman, A.N.K. (2004): "Transformation of Agriculture in North-Western Districts of Bangladesh." *Bangladesh Journal of Political Economy*, Volume 18, Number 1, June 2003, Dhaka, Bangladesh.
3. Noman, A.N.K. and Joarder, S. (2010): "Transformation of Agriculture in the North-Western Bangladesh: Exploring the Vulnerabilities of the Poor People's Livelihood and Adaptive Capacity", unpublished research report, Department of Sociology and Department of Economics, University of Rajshahi, Bangladesh.
4. Noman A.N.K. and Joarder S. (2011): "Climate Change, Agricultural Transformation and Issues of Food Security in Bangladesh", *Bangladesh Economic Studies*, Vol. 13, June 2011, Rajshahi University Economic Association, Department of Economics, University of Rajshahi, Bangladesh. ISSN 0526 1662

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 151-168
Bangladesh Economic Association
(ISSN 2227-3182)

Drought and Public Policy Concerns for North-Western Region of Bangladesh

Md. Atiqul Islam*
A.N.K. Noman**

Abstract *Drought is one of the many climatic hazards Bangladesh currently faces and the north-western region is particularly affected by it. It is changing the basic characteristics of this region slowly but permanently. The impact of other climatic hazards, such as floods and cyclones is sudden, devastating and shocking, and always draws more media attention. On the contrary, the impact of drought is slow and less appealing to the policy makers and few people are found to campaign for it. This article intends to put some light on this issue. For that purpose, policy and strategic documents of the government, journal articles, books and reports are thoroughly reviewed and actions taken by the government to meet the challenges of drought are highlighted. A comprehensive plan and action is required to face this challenge. Along with other interventions, investment in irrigation infrastructure is the foremost. It is suggested that development and utilization of surface water (SW) resources to maintain irrigation requirement is indispensable to reduce the growing pressure on the ground water (GW) reserves. Though huge investment is required, through this investment government will actually ensure the food security for the economy. Government should take appropriate policies to keep the agricultural activities of the region intact. Otherwise, it may be a serious problem to not only the north-western region but to the economy as a whole.*

Keywords: *Drought, Northwestern Region, Climate Change, Agriculture, Irrigation, Public Policy Concern, Bangladesh.*

* Associate Professor, Department of Economics, University of Rajshahi
** Professor, Department of Economics, University of Rajshahi

Introduction

Bangladesh is situated in one of the most disaster prone areas of the world. The climate change is making the situation worse. Drought is one of the serious climatic hazards that Bangladesh faces these days. Floods and cyclones are sudden, devastating and shocking, and always draw more national and international media attention. This always puts additional pressure on the policy makers to act. This also attracts many nongovernmental organizations and pressure groups to campaign for policies and allocations for relief. On the contrary, the drought occurs slowly and from the risk perception point of view this event does not get much serious attention. As the impact of drought is slow and less appealing to the policy makers, few people are found to campaign for it. But it can cause a greater damage to crops and affect more people across the wider area than flood or cyclone. It may seriously affect our livelihood and even the existence of some plants and animals. So, the risk related with drought has to be taken seriously. This paper intends to put some light on that drought issue along with the public policy concerns for that in Bangladesh. More focus is given here to agriculture and irrigation issues in the north-western region.

Review of Literature

Dey and others (2011) did a study on the biophysical and environmental issues concerning drought occurrence in NW region of Bangladesh. Using both primary and secondary data, the analysis showed that the rainfall was almost 46 percent lower than the normal period. Similarly, average monthly sunshine hours was about 7 percent higher and ground water level declined more than one meter during the drought period compared to that of the normal years. It concluded that among all these factors, shortage of rainfall was the dominant one for the occurrence of drought in the region.

Paul (1995) did a research on the drought of 1994-95 in Bangladesh. He analyzed the means through which the residents of the drought affected area (northwestern part of Bangladesh) coped with the situation. The analysis of the data suggested that both high and low income households were severely affected and the governmental responses were delayed and inadequate to provide financial and other assistance to the drought victims during the drought period. This study suggested that the government should prepare for drought long before the occurrence of such events.

Islam (2011) did a research on the dynamics of farmers' adaptation in Rajshahi district, which is in the NW region of Bangladesh, using case study method in a very limited scale. It found that farmers were very much aware of the warming trends, water scarcity and weather variability related to drought in that area. One of the key conclusions drawn in that study is that government initiative, which should be the main driver to farmers' adaptation, was considerably lacking.

Islam (2013) reviewed the issues for developing countries in the face of climate change. This review paper showed that climate change poses threat to agricultural sector of developing countries. Therefore, a key challenge for the developing countries is to identify actions to reduce vulnerability in the agricultural sector. Through appropriate actions the impacts of climate change can be avoided or at least reduced. In this respect government intervention is very much needed to facilitate adaptation to because of market climate change (Aakre and Rübbelke, 2010).

Drought has received much less attention of researchers than floods and cyclones. In an annotated bibliography of social science literature on natural disaster in Bangladesh, only 11 titles on drought were found against 156 for floods and 54 for cyclones (Alam, 1995). Apart from that, to the best of our knowledge, there is no such research paper emphasizing public policy concerns related to drought especially in the NW region of Bangladesh. The present research is an attempt to fill that gap.

Objectives of the Research

General objective of this research is to review the present scenario of drought and the status of actions taken so far from policy perspectives. However, for the analytical purpose several specific objectives are identified. These are:

1. To highlight the present status of climatic hazard Bangladesh is facing, especially the drought in Bangladesh.
2. To analyze the status of actions so far taken by government to fight against drought in the North-Western (NW) Bangladesh.
3. To have some policy suggestions to cope with the drought for NW region.

Before dealing with the research methodology and findings of the research, definitions of drought and its effects are conceptualized in the next section. The climatic hazard *Bangladesh is facing* because of *Droughts* and the *Impact of past droughts are discussed*. This is followed by a discussion of government actions to combat climate change. Different issues related with the drought, its future consequences, present adaptation and future need for the northwestern region with respect to irrigation are discussed in the next section. The *policy suggestions* and the concluding remarks are presented in the final two sections.

Conceptual Issues

Drought and its impacts

Various definitions are there for drought and they are used to meet specific goals such as agricultural development or water resource management (Paul, 1995). From the agricultural perspective, it can be defined as "shortages of water, which is harmful to our agricultural activities". It occurs as an interaction between agricultural activities (i.e. demand) and natural events (i.e. supply), which results in a water volume or quality inadequate for plant and/or animal needs (Heathcote, 1974). In the context of Bangladesh, Brammer (1987) defines it as a period when soil moisture is less than what is required for satisfactory crop growth during a season when crops are normally grown. Non-availability of water resources as a result of less or no rainfall with more intense sunshine is the main climatic reason for less moisture in the soil or atmosphere (Dey et al., 2011). Apart from these climatic reasons, the human induced alterations resulting from vegetation loss and over exploitation of water resources are the other reasons for drought.

The impact of drought is diverse and its effect ripples through the economy. Overall, the impacts can be classified as direct (or first order) and indirect (or second order) (Kates et al. 1985). In an agricultural economy, the direct impact would be in the form of reduction of crop production via decrease in acreage and yield. The second order impact would be in the form of decrease in employment and income. Decrease in acreage reduces agricultural employment as it diminishes the need for preparing land, weeding, and harvesting. Further impacts can be felt through the rise of food grain prices because of reduced food production (Ghose, 1982). At this stage, the small farmers and landless labourers would be in a very difficult situation. They are then compelled to buy food by selling their assets (i.e. agricultural land, household goods, livestock and other valuables) at a distressed price (Reardon et al. 1988). Even at an extreme condition people start consuming those that are not normally eaten (Jallow, 1995) and this may lead to famine at the end.

Methodology

This research is based on extensive library work. Literature review method is employed here by reviewing the secondary publications. These secondary materials are journal articles, books, policy and strategic documents of

Bangladesh government related to our research topic. The texts of these materials are reviewed thoroughly to have the findings related to our research objectives.

Findings

Climatic hazards Bangladesh is facing

The geographical setting of Bangladesh makes her more vulnerable to different natural disasters. Every year one or more calamities occur in different parts affecting her people's lives, property and livelihood. The main natural hazards that the country suffers and may suffer in future includes flood, cyclone and storm surge, flash flood, drought, tornado, earthquakes, riverbank erosion, and landslide National Adaptation Program of Action (NAPA, 2005). It is feared that the climate change will exacerbate the situation more intensely. It would also increase the

Table 1 : List of Climatic Hazard Bangladesh is facing

➢ Flood & Flash Flood	➢ Drought, Extreme Temperature
➢ Cyclone & Storm Surge	➢ River Bank Erosion & Landslide
➢ Erratic Fog, Hailstorm, Rainfall	➢ Earthquake

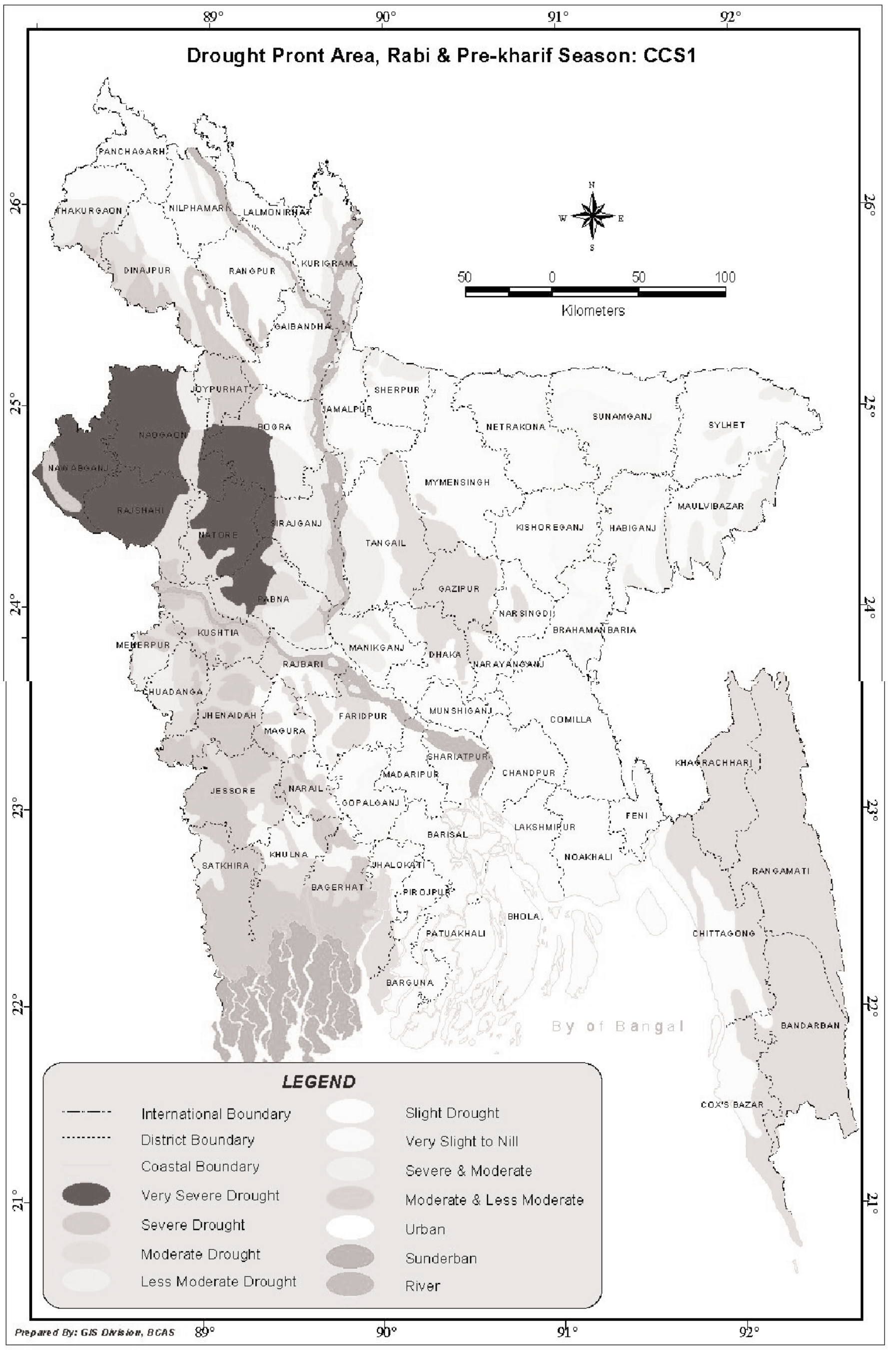
frequency and intensity of those calamities. It is also feared that climate change would cause a sea-level rise and as result some parts of Bangladesh's land area would be under inundation by 2050 (Nishat and Mukherjee, 2013a).

Droughts in Bangladesh and future scenario

Drought is a recurring phenomenon in Bangladesh (Alam et al., 2013; Hossain, 1990). Every five years, Bangladesh is affected by major countrywide droughts. From 1960, drought occurred 20 times in Bangladesh (Dey et al., 2011; Banglapedia, no date). Very strong droughts hit the country in 1961, 1975, 1981, 1982, 1984, 1989, 1994 and 2000. There are strong evidences that climate change will change the rainfall pattern and consequently more frequent drought will occur. North-Western (NW) region, popularly known as North-Bengal, is characterized by high temperature and low rainfall compared to average condition of Bangladesh. The region is primarily prone to drought which is likely to become more frequent and severe due to climate change (Nishat and Mukherjee, 2013b; Habiba et al. 2013; NAPA, 2005).

More erratic rainfall and temperature in the NW region are already felt in the grass root level (Islam, 2011). Scientific evidence shows that the temperature will rise, and there exists a strong possibility that the precipitation will decrease further, it

Map 1 : Projected Drought Prone Areas of Bangladesh in 2030 (NAPA 2005, p 15)



is likely that the moisture content of topsoil would decrease substantially (Nishat and Mukherjee, 2013b). Higher temperature would, furthermore, induce higher rate of evapo-transpiration leading to acute droughts in this region. One major impact would be availability of water for agricultural production in this region. As a result it is expected to be the most vulnerable rice-growing region in future (Basak, 2010).

Impact of past droughts in Bangladesh

Lower crop production is the main consequence of drought in Bangladesh (Rahman and Biswas, 1995). It may affect adversely all three rice varieties (*aman, aus, boro*) that grow in three different cropping seasons. The loss of rice production due to drought in 1982 was 52,896 metric tons (BBS, 1986, p. 287-290). This was about 41 percent of the total damage caused by all types of environmental hazards (cyclones, hailstorms, heavy rains, floods and drought) that occurs in that year (Paul, 1995). During the period of 1973-87, crop losses to drought were almost as severe (2.18 million tons of rice) as the losses attributed to floods (2.38 million tons of rice) (Hossain, 1990, p. 37). Sometimes the loss caused by drought is greater than the losses caused by the flood and cyclones (Paul, 1998; Selvaraju et al., 2007). Even, it can put people in a more defenseless situation than floods and cyclones (Shahid and Behrawan, 2008; Shahid 2010). Paul (1995) found that 15 different crops were affected by drought of 1994-95 and the loss in crops was attributed to both decrease in acreage and yield of crops. The percentage of total *aman* acreage damage was from 45 percent to 100 percent with average damage of 75 percent. Nearly 65 percent and 55 percent of the *aus* and jute acreage were, respectively, damaged by that drought. Overall, we can say that depending on the intensity of drought, the estimated yield reduction of different crops varied from 10 percent to 70 percent (Banglapedia, no date). Consequently, it lowers the employment opportunities, reduces the asset holding and raises the household's food insecurity in Bangladesh.

Government initiatives so far taken

There are several policies, strategic documents and projects in Bangladesh for the future improvement of the economy. Government's understanding of the drought issues of NW region and actions taken so far to fight against drought are discussed in the following.

1. National Adaptation Program of Action (NAPA) 2005: In response to the decision of the Seventh Session of the Conference of the Parties (COP7) of the United Nations Framework Convention on Climate Change (UNFCC)

Bangladesh was prepare a National Adaptation Program of Action (NAPA). The country launched the NAPA in 2005 which identified 15 priority activities. Though the risk of drought that the country would face in future was acknowledged, only one among the fifteen of those priority areas was related to drought and that one is to promote research on drought resilient variety of crops. Later on NAPA was further updated in 2009 and identified 45 adaptation measures but adaptation to the improvement in the irrigation system in the NW region did not get attention yet.

2. National Food Policy 2008: The Ministry of Food and Disaster Management prepared the National Food Policy, which serves as another important strategic document for adequate and stable supply of safe and nutritious food to the nation. Here a total of 26 areas of intervention were identified but nothing was mentioned to fight against drought.

3. Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009: This is another comprehensive strategy paper prepared by the Government of Bangladesh to address climate change challenges. Forty four programs have been identified and prioritized within six thematic areas there. Among these 44 programs only one is directly related with drought. That program is related to research and development on climate resilient cropping system and drought management options for farmers. There is no specific program for the improvement of irrigation in the northwestern part of Bangladesh to fight drought.

4. Ministry of Environment and Forest (MOEF): The MOEF is one of the important agencies of Bangladesh government for planning, promoting, coordinating and overseeing the implementation of environmental and forestry programs. We find that 25 projects were implemented under this Ministry throughout the country during the period of 2009-2014. But it is matter of great concern that there is only one project that is related with forestation in Barind tract which can be related to drought.

5. Sixth Five Year Plan (SFYP) 2011-15: Sixth five year plan is another main strategic document for the country. It provides strategy, framework and guidelines for reducing regional disparity, developing human resources, managing resources, increasing agricultural productivity, increasing income and employment, and ensuring food security. Under the Environment, Climate Change and Disaster Management section of this document it has acknowledged the risks posed by increasing drought tendency in the northwestern region. Under this section 35 programs in total were proposed

but only two are related with drought. One of them is to develop the institutional capacity for research on climate resilient cultivars and another one is adaptation against drought. But no target was there related to the second one. There was no specific direction to fight against drought through irrigation either.

6. National Agriculture Policy (NAP) 2013: The Ministry of Agriculture has acknowledged the climate change issue in its National Agriculture Policy 2013. Though it was intended to conduct the research and extension service to support climate change adaptation, not much emphasis was given to drought or to improve irrigational facilities to fight against drought in northwestern part of Bangladesh.

7. Ministry of Agriculture (ADB projects 2013-14): The Ministry of Agriculture is one of the key ministries of Bangladesh government. It is responsible to implement agricultural policies, plans, projects, programs and regulations for the betterment of our agricultural sector. Under ADB Projects 2013-14, there are 62 projects in this ministry and only 3 of them are under Barind Multipurpose Development Authority (BMDA). They are basically related with routine work like to establish new deep tube well (DTW), and repair existing damaged DTWs and canals. Though we may consider these as projects related to drought, there was no other project to fight against drought.

8. Perspective Plan 2010-21: The government has prepared a Perspective Plan covering the period from 2010 to 2021 which aims at implementing *Vision 2021*[1]. Though "achieve food security" and "pursue environmental friendly development" have been specially mentioned under the broad development goals, the drought of NW region does not get much serious attention there. In the fourth chapter (Strategy for Food Security: Agricultural and Rural Development) of this document under the subheading of *crop sector* and *water resource management* it has mentioned 25 strategies but not a single one is there related to drought or irrigation to face the challenges of drought. Like the same, chapter thirteen (Environmentally Sustainable Development) does not include any strategies related to irrigational development in the northwestern region to fight against drought, though it acknowledged the threat of drought in the face of climate change. Under these two chapters only one strategy among the 44 related to improving climate resistance crops can be indirectly related to the drought.

9. Bangladesh Climate Change Trust Fund: To reduce the impact of climate change a trust fund was created to finance the projects in 2010. Since then the

Table 2 : Government initiative so far taken related to drought in the North-Western region

Policy & Strategic Documents/Action plan	Projects/Strategies/ Objectives/ Priority Activities (Total)	Related with droughts	Focal Point
NAPA 2005	15 (Priority Activities)	1	Promote of research on drought resilient crops
National Food Policy 2008	26 (Area of Intervention)	0	Nothing on drought
BCCSAP 2009	44 (Programs)	1	R & D on the climate resilient cropping system and drought management option for farmers
Ministry Of Environment & Forest (MOEF)	25 (Projects for the period of 2009-2014)	1	Related to forestation in 'Barind Tract'.
Sixth Five Year Plan (SFYP) 2011-15	35 (Proposed Program)	2	Related to research on climate resilient cultivars and adaptation to climate change, even no specific target was set and no concern on irrigation
National Agric ulture Policy (NAP) 2013	9 (objectives)	0	Nothing to fight against drought
Ministry of Agriculture	62 (Projects of ADB on 2013-14)	3	Related to irrigation under BMDA and these are routine projects. Nothing is there emphasizing the drought.
Perspective Plan 2010-2021	44 (Strategies to attain food security & Sustainable Dev.)	1	Only acknowledged the need of drought resilience seeds and efficient irrigation but no specific or concrete action.
Bangladesh Climate Change Trust Fund	207 (Projects for 2014)	4	Research on drought resilient crops, excavation and re-excavation of water-bodies & forestation. Only 0.9 percent of total expenditure.

Source: *Own documentation, 2014*

fund is utilized to prepare, implement and finance the projects that are somehow connected to climate change mitigation and adaptation projects all over Bangladesh. We find that there are 207 projects approved by the fund to be implemented in the year 2014-15 by the different ministries, organizations, and agencies, both government & non-government. Again it is surprising that only 4 projects are there which are related to drought in northwestern part of Bangladesh. These are again related with research on drought resilient crops, forestation, excavation and re-excavation of water bodies and the expenditure on those are below 1 percent of the total expenditure on all projects.

Government initiative so far taken that is discussed above is summarized in table 2. It can be seen there that the initiatives are very few to deal with the drought issues of NW region and there is no firm steps regarding the improvement of the irrigation in this respect.

Table 3 : Importance of Northwestern region in Bangladesh

	Area under cultivation for rice in 2008 (%)			Rice Production (%)	Population (%)	Labour Force 2010 (%)
	Aus	Aman	Boro			
Bangladesh	100	100	100	100	100	100
Northwestern region	20	42	35	32	24	27

Source: *BBS, 2012*

Discussion

Concerns over the drought issue in the NW region and suggestions in that regard are discussed here.

This region is one of the important areas of Bangladesh providing agricultural products in the whole economy. The gravity of the situation can be seen from table-3 also.

---

[1] Vision 2021 is the political manifesto of the Bangladesh Awami League, the present ruling party in the government, before winning the National Elections of 2008. It still stands as a major political vision of Bangladesh for the year 2021, the golden jubilee of the nation. This would be implemented through successive five years plans.

This region contributes one third of the total rice produced in the country. The total population of the region is less than one fourth of total population. Hence, it appears that this region provides its surplus produces to the rest of the economy. So, overall we may deduce from the agricultural production perspective that this region needs more attention. Anything that happens to the agricultural sector in this region will affect the economy through unemployment, income deficit, and instability of agricultural production.

Most of the crops are produced at the very marginal level of profit all over the country especially in this region. Irrigation is one of the important parts of crop production, which contribute to food security by producing high yield varieties. In the face of future drought its importance will definitely increase further. The cost of irrigation is very high in Bangladesh. This cost can be as high as 40 percent of farmer's total production cost, and lack of timely irrigation leads to a 37 percent average decrease in yield of rice and other crops (Chowdhury, 2012; Katalist, no date). Conversely, efficient irrigation can increase both the productivity and profitability of the agricultural farm. This cost would increase with the level of drought and as a consequence this would reduce the profit margin. An assessment on irrigation shows that the major hindrance in the efficient irrigation system in Bangladeehs are a) lack of knowledge of farmers on crop specific water management system; and b) unavailability of efficient low-cost irrigation system. For example, in Northern Bangladesh, the Boro rice farmers use three to five thousand liters of water to produce one kilogram of paddy, while the actual requirement is only about 1500 liters (Chowdhury, 2012). This over usage of water not only impacts negatively on environment by depleting water levels, but also increase farmers' production cost and thus decrease their net income.

Agricultural adaptation in the form of agricultural transformation would be expected without any intervention under the drought circumstances. Evidence also suggests that farmers are adopting new crops like sugarcane, maize corn, potato, wheat, different types of pulse and oil seeds (Habiba et al., 2013). One of the important transformations that is occurring here in some part is the transformation of paddy field to mango orchard. Water scarcity is one of the main factors that influence the decision making process in this transformation (Noman et al. 2011). Scarcity of water increases the cost of irrigation in the production and influences the profit to rice cultivation. On the other hand mango orchard requires less irrigation and the return is much higher. Apart from that, some policies at the public as well as NGO level are also promoting different adaptation. Projects jointly funded by the Food and Agriculture Organization (FAO) and Government of Bangladesh under the supervision of the Department of Agriculture Extension in the name of Livelihood Adaptation to Climate Change (LACC) and Disaster and Climate Risk Management in Agriculture (DCRMA) advocate this sort of transformation. Along with the mango orchard they are promoting different drought resistance cultivars like wheat, chickpea, maize corn and different pulses. Some NGOs are also promoting this sort of transformation by providing credit.

One of the major impacts of this transformation is that less area would be available for the rice production in some parts of NW region. Noman and others (2011) found that 41 percent of their study area of Porsha thana under Noagoan district have already been transformed and is going to be 80 percent within the next 10 years. As a consequence, there would be a fall in rice production up to 70 percent which means this region would no longer be the surplus producer of rice and even no longer be able to produce its own demand for rice. Apart from the mango transformation, let us consider the other crops which are producing like maize corn, wheat and so on, which are drought resistance crops. If these crops substitute the rice production then another concern is there. If our food habit changes from rice to whatever we are producing then we may have no problem. If it is not, then it will put Bangladesh in a great difficulty to maintain its food-population balance. Though, some may argue that she would import more and more rice from the international market that she is even doing now. But in that case we have to remember that the international food supply is also under constant threat at the changing climatic condition and growing population worldwide. Uncertainty of food supply in the international market is also increasing. Depending on the international market for domestic food supply would make us more vulnerable to both food as well as national security perspective.

Exploitation of groundwater (GW) has already been implemented under the Barind Multipurpose Development Project (BMDP). After the introduction of BMDP in 1986, 6000 deep tube wells (DTW) have been installed in the area. In addition to that about 66000 shallow tube wells (STW) were also installed in private sector by the year 2000 for the exploitation of GW for the irrigation. Barind Irrigation Projects is located within the Barind Tract area, which covers most part of Northwestern districts. All rivers and canals of this region dry up during the dry season, and make the people completely dependent on GW, especially for the irrigation. About 75 percent of water for irrigation in the region comes from GW (Bari and Anwar, 2000). To protect the GW the BMDP have taken measures so that the annual withdrawal is less than the annual recharge to keep the GW level in position. But the estimation of GW recharge is not certain. Asaduzzaman and Rustome (2006) estimated that GW recharge in the area is at least one third of annual rainfall, and that is about 500 mm per annum. A government report suggests that recharge to GW in the northwestern part varies between 210-445 mm (Shahid & Hazarika, 2010). Again Islam and Kanungoe (2005) estimated the long term annual average recharge at 152.7 mm. It is also revealed from their research that the sustainable yield of GW (204 mm per year) is somewhat higher than the long term annual average recharge (152.7 mm per year) to the GW reservoir. Overall, it has led to an overexploitation of the GW and GW-based irrigation system in the area has reached a critical phase. A report on GW zoning map published by BADC (2005) shows that 60 percent of irrigated croplands in Noagoan district, and 10 percent in Rajshahi and Chapainawabganj districts have become critical for STW operation. Another study in the Noagon district within the Barind Irrigation Project shows a significant declination of GW table because of extensive GW withdrawal, which indicates that GW drought is a regular occurring events here (Adhikari et al., 2013).

At the end of our discussion we may say that if the situation continuously prevails like this and government does not take any serious action then it would create a serious threat to not only the agricultural production of this region but also create other problems through out the economy. So, the government has to take initiative to improve irrigational facilities here. As the GW facilities are in a critical stage, attention should be given to the surface water availability. In this respect China could the model for us. China began to develop its irrigation system in 1949. During 1949 to 1980, the Chinese government invested heavily in irrigation projects such as canals, reservoirs, dams, and wells (Zhu et al., 2013). To fight against drought, they are now putting emphasis on water saving irrigation, optimizing irrigation management, and modernization of large scale irrigation. Water-saving irrigation like the sprinkler irrigation, micro-irrigation, low-pressure pipe irrigation, and canal lining irrigation are now being implemented there.

Policy suggestions

Related to agriculture in the face of drought in the NW region certain policy suggestions are presented below:

We find that the government did not take the drought issue in the NW region seriously. It has to be taken seriously and will need a proper planning. With the support of FAO Bangladesh government have already prepared a master plan for agricultural development in the Southern region. Similar type of plan for the overall agricultural development for the NW region is required.

Proper planning requires knowledge on different issues from the grassroots level as well as available technology. to gut information on grassroots situation (like the soil, weather, water availability, cultivation practices and so on) there is the need to create a data base at the union level and it has to be updated from time to time. NGOs who are working on the area can be used for that purpose.

Irrigation facilities have to be improved, for which there is no alternative. There is the need to develop irrigation infrastructure and flexibility to cope with available technology. A comprehensive plan should be adopted to develop integrated irrigation approach, which could include rain water harvesting, flood water harvesting and sustainable level of underground water use and also change in the cropping pattern.

Ground water irrigation is no longer a dependable means for future drought scenario. We need to improve the surface water availability. To improve the water reservoirs a huge investment is required. The infrastructural and other system development related to the NW region is needed. Investment done in China can be a model for that.

Conclusion

Drought is one of the main challenges that the NW region is facing now and the severity of the problem is likely to increase more in future. It seems that though the government is aware of the issue, they lag in terms of actions. A comprehensive plan and action is required to face this challenge. Along with other interventions, investment in irrigation infrastructure is the foremost requirement for this region. It is suggested that development and utilization of SW resources to maintain irrigation requirement is indispensable to reduce the growing pressure on the GW reserves. Through this investment government will actually ensure the increase in food production, increase in farmers' income, stabilize food prices, and maintain food supply to the whole economy. Otherwise, it may be a serious problem not only the region but also for the whole economy. We hope that the Bangladesh government would take this issue seriously and take necessary actions as early as possible.

References

1. Aakre, S., and Rübbelke, D. T. G. (2010) 'Objectives of public economic policy and the adaptation to climate change', *Journal of Environmental Planning and Management*, 53, (6), pp. 767-791
2. Adhikari, S.K., Das, S.K., Saha, G.C. and Chaki, T. (2013) 'Groundwater Drought Assessment for Barind Irrigation Project in Northwestern Bangladesh', Proceedings of the 20th International Congress on Modelling and Simulation, Adelaide, Australia, 1-6 December, pp. 2917-2923
3. Alam, S.M.N. (1995) *Social Science Literature on Natural Disaster in Bangladesh: A Source Book*. Dhaka: PACT Bangladesh/PRIP
4. Alam, A.T.M.J., Rahman, M.S., Saddal, A.H.M. (2013) 'Monitoring meterological and agricultural drought dynamics in Barind region Bangladesh using standard precipitation index and Markov chain model', *International Journal of Geomatics and Geosciences*, 3, (3), pp. 511-524
5. Asaduzzaman, M. and Rushton, K.R. (2006) 'Improved yield from aquifers of limited saturated thickness using inverted wells', *Journal of Hydrology*, 326, (1-4), pp. 311–324
6. BADC (2005) *The Minor Irrigation Survey Report of 2005,* Dhaka: Bangladesh Agricultural Development Corporation
7. Basak, J. K. (2010) *Climate Change Impacts of Rice Production in Bangladesh: Results from a Model*, Dhaka: Unnayan Onneshan – The Innovators [online] Available at: <http://www.unnayan.org/ limate_Change_Impacts_on_Rice_Production_in_Bangladesh_Report-Copy.pdf> [Accessed on 17th April 2014]
8. Bari, M.F. and Anwar, A.H.M.F. (2000) 'Effects on irrigated agriculture on groundwater quality on Northwestern Bangladesh', *Proceedings of Integrated Water Resource Management for Sustainable Development*, Vol. I, New Delhi, pp. 19-21
9. BBS (2012) *Statistical Yearbook of Bangladesh 2012,* Dhaka: Bangladesh Bureau of Statistics, Ministry of Planning, Peoples Republic of Bangldesh
10. BBS (1986) *The Bangladesh Census of Agriculture and Livestock: 1983-84: Structure of Agricultural Holdings and Livestock Population*. Dhaka: Bangladesh Bureau of Statistics
11. Brammer, H. (1987) 'Drought in Bangladesh: Lessons for Planners and Administrators', *Disasters* 11, (1), pp. 21-29.
12. Chowdhury, N.T. (2012) 'Irrigation Institutions of Bangladesh: Some lessons', *In:* Kumar, M. (Ed.), *Problems, Prospects and Challenges of Agricultural Water Management,* InTech Publishing, pp. 113-132

13. Dey, N.C., Alam, M.S., Sajjan, A.K., Bhuiyan, M.A., Ghose, L., Ibaraki, Y., and Karim, F. (2011) 'Assessing Environmental and Health Impact of Drought in the Northwest Bangladesh', *Journal of Environmental Science & Natural Resources*, 4, (2), pp. 89-97

14. Ghose, A.K. (1982) 'Food Supply and Starvation: A Study of Famines with Reference to the Indian Sub-Continent', *Oxford Economic Papers,* 34, (2), pp. 389-398.

15. Habiba, U., Hasan, A.W.R. and Shaw, R. (2013) 'Livelihood Adaptation in the Drought Prone Areas of Bangladesh', *In:* Shaw, R., Mallick, F. and Islam, A. (Ed.) *Climate Change Adaptation Actions in Bangladesh,* Springer, pp. 227-252

16. Heathcote, R.L. (1974) 'Drought in South Australia', *In*: White, G.F. (Ed.) *Natural Hazards: Local, National, Global*, New York: Oxford University Press.

17. Hossain, M. (1990) 'Natural Calamities, Instability in Production and Food Policy in Bangladesh', *The Bangladesh Development Studies*. 18, (1), pp. 33-54.

18. Islam, M.A. (2013) 'Agricultural Adaptation to Climate Change: Issues for Developing Countries', *Global Disclosure of Economics and Business,* 2, (2), pp. 30-41

19. Islam, M.M. and Kanungoe, P. (2005) 'Natural recharge to sustainable yield from the Barind acquifer: a tool in preparing effective management plan of groundwater resources', *Water Science & Technology,* 52, (12), pp. 251-258

20. Islam, M.A. (2011) *Farmers' Adaptation to Climate Change in Bangladesh: A Case Study of Rajshahi District,* Germany: LAP LAMBERT Academic Publishing

21. Jallow, S.S. (1995) 'Identification of and Response to Drought by Local Communities in Fulladu West District, the Gambia', *Singapore Journal of Tropical Geography.* 16, (1), pp. 22-41.

22. Katalist, (no date) Irrigation, [online] Available at: <http://www.katalyst.com.bd/op_Irrigation.php> [Accessed on 22th April 2014]

23. Kates, R.W., Ausubel, J.H. and Berberian, M. (1985) *Climate Impact Assessment,* New York: John Wiley & Sons, Inc.

24. Nishat, A. and Mukherjee, N. (2013a) 'Sea Level Rise and its impacts in Coastal Areas of Bangladesh', *In:* Shaw, R., Mallick, F. and Islam, A. (Ed.) *Climate Change Adaptation Actions in Bangladesh,* Springer, pp. 43-50

25. Nishat, A. and Mukherjee, N. (2013b) 'Climate Change Impacts, Scenario and Vulnerability of Bangladesh', *In:* Shaw, R., Mallick, F. and Islam, A. (Ed.) *Climate Change Adaptation Actions in Bangladesh,* Springer, pp. 15-41

26. Noman, A.N.K., Joarder, M.S. and Islam, A.K.M.S. (2011) *Transformation of Agriculture in the North-Western Bangladesh: Exploring the Vulnerabilities of Poor People's Livelihood and Adaptation to Climate Change,* CCA-DRR Project Repot, Dhaka: Action Aid Bangladesh

27. Paul, B.K. (1995) 'Farmers and Public Responses to the 1994-95 Drought in Bangladesh: A Case Study', *Quick Response Report 76*, USA: Department of Geography, Kansas State University [online] Available at: <http://www.colorado.edu/hazards/research/qr/qr76.html> [Accessed on 17th April 2014]

28. Paul, B.K. (1998) 'Coping mechanisms practices by drought victims (1994/95) in North Bengal,

29. Bangladesh', *Applied Geography*, 18, (4), pp. 355-373

30. Rahman, A. and Biswas, P.R. (1995) 'Devours Resources' *Dhaka Courier,* 11, (42), pp. 7-8

31. Reardon, T., Matlon, P.J. and Delgado, C. (1988) 'Coping with Household-Level Food Insecurity in Drought Affected Areas of Burkina Faso', *World Development,* 16, (9), pp. 1065-1074.

32. Selvaraju, R., Subbia, A.R., Bass, S. and Juergens, I. (2007) *Livelihood adaptation to climate variability and change in drought-prone areas of Bangladesh,* Asian Disaster Preparedness centre, Food and Agriculture Organization of the United Nations, Rome, Italy

33. Shahid, S. (2010) 'Rainfall variability and the trends of wet and dry periods in Bangladesh', *Hydrological Processes,* 30, pp. 2299-2313

34. Shahid, S. and Hazarika, M.K. (2010) 'Groundwater Droughts in the Northwestern Districts of Bangladesh', *Water Resource Management,* 24, (10), pp. 251-258

35. Shahid, S. and Behrawan, H. (2008) 'Drought risk assessment in the western part of Bangladesh', *Natural Hazard,* 46, pp. 391-413

36. Zhu, X., Li, Y., Li, M., Pan, Y., Shi, P. (2013) 'Agricultural irrigation in China', *Journal of Soil and Water Conservation,* 68, (6), pp. 147A-154A

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp.169-188
Bangladesh Economic Association
(ISSN 2227-3182)

Impact of Farm Mechanization on Productivity and Profitability of Rice Farm in Rajshahi District

Md. Selim Reza*
Md. Moazzem Hossain Khan**

Abstract *Rajshahi is a district of North Bengal part of Bangladesh, which is basically an agricultural area, where growing crops is the main activity of the people although some people engaged are also in non-farm activities. Rice is the main crop of the study area. Farmers can grow rice very easily in the Barind area under the Barind Multipurpose Development Project where farmers get irrigation facility at cheap cost. Due to shortage of rainfall and shortage of underground water farmers of Puthia, Charghat and Bagha thanas are dropouts from rice cultivation and transform their agricultural land into fruit tree as well as wooden tree plantation (Noman and Joarder, 2011). The finding of the study is that among the three categories of tillage methods such as power operated, animal operated and power plus animal operated (pooled) tillage, most of the farmers use power tiller/tractor for tilling their land and still some farmers use animal power for tilling. Combine tillage method (power and animal operated) is also found in the study area. It is found from the study that the actual productivity of the inputs is very low compared to the optimal attainable production. Due to lack of modern technology, high input cost, and low market price, the profit margin is very low of Boro and Aman paddy. Farmers in the study area have faced different kind of problems in the case of using modern technology and rice production. Poor buying capacity, small farm holding, high market price of machines and spare parts and labour shortage are the major constraints in the improvement of mechanization. Natural disaster like drought hampers the crop production.*

* Assistant Professor, Department of Economics, University of Rajshahi
** Professor, Department of Economics, University of Rajshahi

The price of fertilizer, mainly the price of urea has doubled within the last three years. Price of diesel has increased day by day, which greatly affects the Boro production. On the other hand, farmers do not get the fair price of their crops. As a result farmers lost their interest in crop production and migrate to industrial areas for searching jobs or to transform their land into mango orchard or wooden garden and sometimes large farmers lease their land to the marginal farmers or give their land to the sharecroppers.

Key Words: *Farm Mechanization, Resources Productivity, Profitability*

1. Introduction

Bangladesh is a small country in South Asia with a population of about 152.5 million, increasing at a rate of 1.37 percent, adding 2 million labour to the existing 72 million every year (BBS 2011, final census report July 2012). Agriculture is the principal economic activity and the basic source of employment (47.33 percent labour force engaged in agriculture sector, Labour Force Survey 2010, BBS), income and export earnings of Bangladesh. It plays a vital role in the economic growth and stability of the country. Despite four decades of planned development efforts and attempts to industrialize the economy, Bangladesh Economy has still remained a rural based economy. Agricultural performance has direct impact on macroeconomic objectives like poverty alleviation, employment generation, development of human resources and attainment of food self sufficiency.

In Bangladesh, agriculture is the third largest sector of the economy (Bangladesh Economic Review 2011), where service is the first and industry is the second largest sector. In FY 1972-73, agriculture sector was the largest sector (49.76 percent of total GDP) but gradually the contribution of agriculture sector has decreased and at present (FY 2011-12) the contribution of agriculture sector is only 19.42 percent (provisional) of total GDP. Though the direct contribution of agriculture sector has been falling, the indirect contribution has been increasing day by day because our service sectors like, wholesale and retail trade, hotel and restaurant, transport and communication as well as the supply of food for industrial labour are strongly supported by the agriculture sector.

Bangladesh agriculture has grown at 3.2 percent annually during 1991-2005 and the dominant source of this growth was the crop sub-sector, which grew at 2.3 percent per annum. Over the last 40 years, Bangladesh has greatly increased its food grain production from 19.06 million metric tons in 1995-96 to 26.69 million metric tons in 2002-03 and 31.12 metric tons in 2007-08. The total food grain production in 2010-11 was 36.06 million metric tons. The contribution of rice in total food-grain production was 93.0 percent in 2010-11and it was 94.56 percent in 2009-10 (Bangladesh Economic Review 2012). Despite the fact agriculture is still the driving force of the Bangladesh economy, it is a tough job to feed the 152.5 million people from 8.2 million hectares of cultivable land. Every year almost 3.0 million people are being added to the total population whereas the estimated annual shrinkage of agricultural land is about 0.08 million hectares due to various non-agricultural activities like construction of houses, offices, roads, mills and factories (BRRI 2009). So, there is no better option to feed the county's huge population except increasing productivity of the existing land.

"Food for all" and "food security" are the prime commitments of the Bangladesh Government. As such, government has given top priority to the agriculture sector to achieve self sufficiency in food grain by 2013 through increased production. Total production or domestic supply of food grains was 36.06 million metric tons in FY 2010-11 and at the same time 5.15 million metric tons of food grains was imported of which 1.55 million metric tons was rice and 3.60 million metric tons was wheat. From this, it can be said that Bangladesh is not self sufficient in food grains production. For attaining food self-sufficiency through increased crop production the use of modern technology, chemical fertilizers, modern varieties of inputs, irrigation facilities and pesticides should be increased.

In 1980-81 the cropping intensity of Bangladesh was 159.69 percent, and it increased to 175.9 percent in 2000-2001 (BBS 2006). To meet the food requirements of the ever growing population of the country in 2015, an additional 5 million metric tons of food grains will be needed to produce from the continuously decreasing lands. So, to achieve this target, there is no other option than to increase production per unit of land as well as cropping intensity, which can be increased up to 250 percent. This will need much heavier investment in technological improvement and modern methods of cultivation.

1.2 Problem Statement

Farm mechanization is the main plank of modern agriculture. Many developed countries revolutionized by using farm mechanization, which resulted in tremendous production and productivity gains. However, the conditions under which it was introduced in those countries differ greatly from Bangladesh context. Two of the most important conditions were the shortage of labour and large size of farm. But as the pressure of population on land is increasing steadily, the solution lies in mechanizing agriculture, which would realize the goal of achieving targeted food gains production in Bangladesh.

The main driving force of the economy of Rajshahi district is agriculture and hence the expansion of agricultural production which is concentrated in rice, wheat, sugar cane, jute and vegetables production. Nevertheless, the potential of agricultural production lies in crop diversification. The crop diversification can be enhanced by farm mechanization in this region. Moreover, the shortage of draught power encourages farmers to use the mechanized system. Farm mechanization helps increase the cropping intensity by providing temporal and partial adjustment in crop production activities so that least time is lost between the two cropping seasons and farmers can raise more number of crops in a given time. The inherency of lobour shortage in agriculture during important field operations like transplanting, weeding, fertilizer application, etc. can be minimized by economic and efficient use of machines. Further, certain activities like deep ploughing in wetland demands the use machinery to improve the quality of operations. The post-harvest operations like threshing, if undertaken, using machines not only reduce the losses but also improve the quality of the product in some cases. The main question to be answered in this study is whether mechanization would help in achieving the objectives of increasing the farm income, inter-alia taking into consideration the more use of farm machineries.

A study of resource productivity on mechanized, non-mechanized and pooled farms may explain the marginal value productivity of inputs among the three categories of farms and justify the investment demands. The measurement of profitability involves the comparison of profit margin among mechanized, non-mechanized and pooled farms.

Further, there is a need to study the changes in the composition and use of the farm machinery in the farms over the years to find out the changes in technology and its adoption by farmers.

1.3 Objectives of the Research

The following objectives are formulated keeping in view the importance of farm mechanization and challenges faced by it.

a. To measure profit margin of rice production under different categories of farms.
b. To analyze productivity changes in agriculture under mechanized and non-mechanized farm.
c. To identify the constraints of using farm machinery and develop the policy initiatives for adoption of mechanization.

Rajshahi district is comprised of nine upazilas named Poba, Tanore, Mohonpur, Godagari, Puthia, Bagmara, Durgapur, Charghat and Bagha. Each upazila is divided into several unions, mouzas and villages. The area of Rajshahi district is 2407 square kilometer and the total population is 2.57million, of which the male population is 1.30 million and female population is 1.25 million (BBS, 2012). Rajshahi is a district of North Bengal region, which is basically famous for agricultural activities. There are some small and medium industries where agricultural commodities are used as raw materials.

Most of the people of Rajshahi district are farmers and agriculture is the main activity of the people along with some non-farm activities. The farmers of the study area grow two or three crops in a year in their land and their major crops are rice, wheat, sugarcane, jute, pulses, oilseeds, maize vegetables etc. It is observed that there have been significant variations of the cropping patterns among upazilas as well as among farmers. From the field survey, it is clear that rice is the main crop of the study area. Farmers can grow crops very easily in the Barind area because under Multipurpose Development Project farmers get irrigation facility with cheap cost. Because of the shortage of rainfall and underground water, farmers of Puthia, Charghat and Bagha thanas are not interested to cultivate rice.

To get a clear insight and comparison of productivity and profitability, we divided the rice farms into three categories such as power operated, animal operated and pooled (power plus animal operated) farms on the basis of tillage methods. In the study area, most of the farmers use power tiller/tractor for tilling their land and a small fraction of farmers use animal power. Farmers in the study area use deep tubewell, low lift pump or shallow tubewell for irrigation and weed out their land by hand and sometimes they use medicine to kill the grass of the field. Farmers harvest their crops manually because of small farm size and no harvesting machine. Threshers are available in the study area. Some farmers have their own threshers and some rent it from others. In the case of crop production farmers have faced different kinds of problems. Natural disaster like shortage of rain hampers the rice production. The price of fertilizer, mainly the price of urea, has doubled over the last three years. Price of diesel has increased day by day which greatly affects the Boro production. On the other hand, farmers do not get the fair price of their crops. As a result farmers lost their interest in crop production and migrate to industrial areas for searching jobs.

1.4 Rationale of the Study

Though Bangladesh is an agricultural country, our farmers are not familiar with modern technology in farming. The use of modern technology has increased in the recent decade compared to 80s and 90s of the last century but the rate is still not satisfactory. Still our farmers do their agricultural activities in traditional way which takes more time and increase production cost. On the other hand, using modern technology saves time and reduces production cost and also increases cropping intensity. Though our local producers have manufactured light machines and spare parts, the diesel engine and heavy machines (tractor, harvesting machine etc.) are imported from abroad. So, it is very necessary to find out the level of mechanization and the constraints which hampered the enlargement of mechanization. World food security and increasing food price in international market are the major concern of policy makers and economic planners. Still Bangladesh couldn't achieve self-sufficiency in food grain production and so, there is no chance of self-content in this matter. Every year more than 1 million metric ton additional food grain will be needed to meet up the over-growing demand of population. To increase the production, it is crucial to find out the productivity of different inputs. Cob-Douglas production function and profit function are used in measuring the productivity and profitability of rice production. This study helps us to find out the gap between actual production and optimal attainable production that can be achieved by readjusting inputs. Since there are very few studies in this area, the findings of the study have filled up some of the gaps in the literature of mechanization and productivity measurement. We hope this research work will help the government, policy makers, and international agencies in policy formulation and its implementation. Finally, future researchers may also benefit from this research work in terms of getting ideas and guidelines for their work.

2. Review of Literature

There has been a continuous debate on the impact of mechanization in agriculture since the days of green revolution. The last few years have added more to the controversy on power tillers and tractors, further complicated by the latest biological and mechanical innovations. It is, therefore, not surprising that apart from the massive amount of research work done by individuals and organizations, there have been frequent demands from the policy makers to undertake further specific studies in this area. Hence the important work carried out on this aspect is reviewed comprehensively to understand the direction of research carried out so far and to evolve a possible improvement over such available studies. Majumdar *et al.* (2009) have explored the difference in the efficiency and productivity among owner, cash tenant and crop share tenant. Total cash expenses as well as total gross costs for producing HYV Boro rice was highest in owner farms and lowest in crop share tenant's farm. When individual inputs were concerned it was observed that expenses on human labour shared a major portion of total expenses in the production of HYV Boro rice where owner operators used more hired labour in comparison to other groups. However, the cash tenant farmers were more efficient than owner and crop share tenant farmers. Due to poor resource base the crop share tenants were unable to invest on modern farm inputs. It may be mentioned that in Bangladesh the predominant tenancy arrangement is share cropping, which is an inefficient form of tenure arrangement compared to cash tenancy.

The Organic method of rice production was more productive than LEISA (low external input sustainable agriculture) and conventional methods. Only 52 USD was spent and 277 McCall of energy used in producing 1 ton of paddy rice through the organic method while 63 USD was spent and 501 McCall of energy were used in LEISA (Mendoza, 2002). The agrochemical input (fertilizer/ pesticides) accounted for 61% of the fossil fuel based energy inputs and 84% of the cash cost of production in the conventional system. Organic rice farmers earn 7 dollars per 1 dollar cash expense while only 2 dollars in conventional and 5 dollars in LEISA. The findings in this case study have shown that the organic method of production is a cost effective (and energy efficient) means of solving the recurring credit problems of capital-scarce rice farmers in the Philippines. The Government extension program should equally promote the organic method of rice production.

Ahmed (1983) has shown that power tiller farms allocated more land to cash crops than animal farms, where food crops (44.5% of land area) and fodder crops (18.7%) occupied larger areas. Yield per acre of major crops was higher on power tiller farms than animal farms. Higher yield rates were the result of greater use of water and fertilizer in addition to power tillerisation on these farms. Total labour input per cropped area was 19.8 percent less on these farms as compared to animal farms. Gross income and total cost per acre were higher by 37.5% and 10.3% on power tiller farms as compared to the animal farms.

Sidhu and Grewal (1990) have found that in spite of replacement of animal power by power tillers and higher use of weedicides, which are labour saving in nature, the area under labour intensive crops like sugarcane, potato and paddy increased. Uses of fertilizers enhanced production and enabled the power tiller farms to employ more human laborers as compared to animal farms.

Sharma (1995) has shown in his study that employment of hired human labour was more on power tiller operated farm, which showed an upward trend among medium and large farms in case of Hissar whereas it showed a reverse trend in Joipur. The average net income was found to be higher in the case of power tiller operated farms at both the phases. A comparison between the elasticity coefficients of animal power and power tiller horse power showed that the use of power tiller increased the output more than by the use of animal power and the sum of the production elasticities were nearly unity indicating constant returns to scale on all the sizes of farms in all the cases

Pandey (2004) discussed that farm equipment are used in farming operations, including immediate post harvest activities, with a view to increasing productivity of land and labour through timeliness of operations, for efficient use of inputs, improvement in quantity of production and safety and comfort of farmers, and reduction in loss of produce and drudgery of farmers.

The different studies reviewed, have investigated extensively on the effects of Power tillerisation on farm labour employment, output and farm income levels. The changes in the cropping patterns and cropping intensity due to the process of mechanization were also studied. There were also attempts on the part of researchers on the policy implications of mechanization strategies and the factors affecting the process of power tillerisation.

3. Methodology

A requisite micro-level study based on the primary cross-section data has been designed to attain the objectives of this study. The methodology has mainly dealt with the sampling procedure, collection of data and analytical framework that are used in this study.

3.1 Sampling

For collecting data, three-stage stratified random sampling design has been used. The present study is conducted in Rajshahi District and the study area lies in nine thanas such as Poba, Tanore, Mohonpur, Puthia, Bagha, Charghat, Durgapur, Godagari and Baghmara. A sample of 135 farmers has been taken from nine thanas for the study. From each thana we have selected one union and then randomly selected three villages for collecting 15 samples of farmers. To select village, we have given priority to those areas where large numbers of machinery are used. Since the study has focused attention on technology adoption and its determinants in a predominantly rice growing area, an attempt is made to choose the villages which had an average level of agricultural performance in their respective sub-regions. We also got agricultural information from thana agricultural office. The sample is selected in such a way that the farmers of each village are the representative of this village.

3.2 Collection of Data

Following the conventional survey technique, primary data on resource availability and their use, input-output levels, prices of farm produce and inputs and some other relevant information were collected by interviewing the farmers personally with the help of suitably designed and pre-tested questionnaire. Secondary data regarding location, climate, soil irrigation, major crop enterprises, population, land utilization pattern, insecticides and fertilizer consumption in of the region were compiled from the records of district and other government publications.

3.3 Analytical Framework

The data were subjected to tabular analysis for examining the cost and returns at different levels of adoption for farm business as a whole and for different crop enterprises separately. The standard cost and income measures were used in this part. The information on level of adoption by constructing suitable indexes has been presented separately.

3.4 Profit Function

Profits for each of the individual crops in the three categories of farms (power operated, animal operated and pooled) were calculated separately. The activity budget as suggested by Dillon and Hardaker (1980) was employed for deriving the profit equation. The profit equation of the following form is used:

$$\pi_1 = P_{yi}.Y_i + P_{bi}.B_i \, | \sum_{i=i}^{n} [\![(P_{xji}]\!] . X_{ji}) - TFC$$

Where

Π_I = profit per acre from ith output,

P_{yi} = per unit price of ith output,

Y_i = total quantity per acre of ith output,

P_{bi} = per unit price of ith by-product,

B_i = total quantity per acre of ith by-product,

P_{xji} = per unit price of jth input used in producing ith output,

X_{ji} = total quantity of jth input used for the production of per acre ith output,

TFC = total fixed costs involved in producing per acre ith output,

I = the number of individual crops produced by the farmers,

J = the number of individual inputs used for producing the relevant product,
n = 1, 2, 3, ... n.

For the lack of exact information, the fixed cost (rent of land) is omitted from analysis.

3.5 Resource Productivity

Production function analysis is used to obtain the marginal value productivity of inputs used in crop production at different levels of technology adoption. For judging the marginal value productivity of the three categories of farms separately, namely the power operated farm, animal power operated farms and pooled farms for different inputs such as labour, seed, fertilizers and insecticides on sample farms, the Cobb-Douglas production function has been used. The impact of farm mechanization on human labour use, fertilizer application, tillage, seed use, irrigation and the net returns of the farms are examined under optimized resources situation. The utility of Cobb-Douglas production function in solving this type of problems precisely and quickly is well known. In general, Cobb-Douglas production function can be written as:

$$Y_{ij} = a\, X_{ij1}^{b1}\, X_{ij2}^{b2}\, X_{ij3}^{b3}\, X_{ij4}^{b5}\, X_{ij5}^{b5}\, X_{ij6}^{b6} e^{ui}$$

In log-linear form the above function can be written as:

$$lnY_{ij} = lna + b_1\, lnX_{ij1} + b_2\, lnX_{ij2} + b_3\, lnX_{ij3} + b_4\, ln\, X_{ij4} + b_5\, lnX_{ij5} + b_6\, ln\, X_{ij6} + u_i$$

Where,

Y_{ij} = per acre output of ith crop on jth type of farm,
X_{ij1} = wage of human labour (work days) per acre for ith crop on jth type of farm,
X_{ij2} = value of manures and fertilizers per acre for ith crop on jth type of farm,
X_{ij3} = value of seed per acre for ith crop on jth type of farm,
X_{ij4} = cost of irrigation per acre for ith crop on jth type of farm,
X_{ij5} = cost of animal or power tiller per acre for ith crop on *jth* type of farm,
X_{ij6} = cost of insecticide per acre for ith crop on jth type of farm,
u_i = error term,
a = technical efficiency coefficient,
b_1, b_2, b_3. . .= production elasticity of the corresponding inputs

4. Results and Discussion

4.1 Profitability

Profitability measures the amount where revenue outweighs the cost. Profit comes out by using some fixed amount of inputs. In order to find out comparative profitability of different cropping patterns, costs and returns of Aman and Boro paddy have been considered. The profitability is measured based on full cost basis by taking consideration of the opportunity cost of the different inputs.

As can be seen in Table-1, the input cost as well as the output value of Boro paddy is higher than Aman paddy of all three categories of farms. The output value of Boro paddy (per acre) in power operated farm is Tk. 45331.58, whereas the total input cost is Tk. 32261.85 and farmers have to spend maximum money for hiring labour and buying fertilizers since the cost of both inputs has increased in the last few years. In Bangladesh the opportunity of non-farm activities has increased because of the flourishing garments industry and expansion of service sector. The rural agricultural labour has migrated to urban industrial areas and as a result labour shortage has occurred in planting and harvesting period. This labour

Table 1 : Profitability of Boro and Aman Paddy of Different Categories Farms in Rajshahi District

Farm Category	Gross value	Labour Cost	Fertili. Cost	Seed Cost	Insect. Cost	Irrigation Cost	Tillage Cost	Total Cost	Profit
Boro (power)	45331.6	16462.1	7443.9	1132.1	1182.6	3390.0	2651.0	32261.8	13069.7
Aman (power)	35122.5	15333.0	5848.3	1098.7	820.5	1795.5	2826.0	27722.1	7400.4
Boro (animal)	47146.3	14655.0	8507.6	1213.5	1428.5	4515.7	2417.7	32738.1	14408.1
Aman (animal)	32740.0	14216.0	6203.6	1033.3	908.6	1821.6	2334.0	26517.3	6222.6
Boro (pooled)	46407.9	16234.1	7126.6	1057.3	1182.2	3825.0	2950.9	32376.3	14031.6
Aman (pooled)	32685.0	15793.5	5963.7	1050.6	1822.5	1822.5	2961.0	29413.8	3271.1

Source: *Author's Own Calculation* shortage has increased labour wage as well as production cost of agriculture in the rural area. Moreover, in 2009 the price of urea fertilizer was doubled from Tk. 10 per kg to Tk. 20 which sharply increased the cost of production. Moreover, urea is the most necessary and highly used fertilizer for rice cultivation. The same scenery has been seen in the case of Boro paddy in animal operated and pooled farms.

The output value of Aman paddy varies between Tk. 32000 and Tk. 35500 of all categories of farms whereas the total input cost ranges from Tk. 27000 to Tk. 29500. In the case of Aman paddy, labour cost is alarmingly high like Boro paddy in all categories of farms. The fertilizer cost of Aman and Boro paddy is almost the same since farmers used more fertilizer in the production of Aman paddy to get higher yield. Since the Aman paddy is cultivated in rainy season, irrigation cost is almost half compared to Boro paddy and low irrigation cost in Barind area has also reduced the average irrigation cost in the study area. If we compare the irrigation cost in Barind area with non-Barind area then it is found that the irrigation cost is double in non-Barind area.

If we compare the profit margin between two crops in power operated farms then it is seen that the profit of Boro paddy is twice compared to Aman paddy because per acre yield of Boro paddy is higher than Aman paddy though the total input cost is little bit higher in Boro production. One of the most important findings of our study is that the tillage cost is high in pooled farm (Tk. 2950.9 per acre) compared to power (Tk. 2651.0 per acre) and animal (Tk. 2417.7 per acre) operated farms in Boro production. The same scenery is found in Aman paddy where tillage cost is higher in pooled farm compared to power and animal operated farms. The profit margin of Boro and Aman paddy supports the comment of the farmers that agricultural activity is no more profitable. Per acre net income from Boro paddy varies from Tk. 13000 to Tk. 14500 whereas the net income from Aman paddy varies from Tk. 3000 to Tk. 7500. If the profit margin remains at this level, farmers in near future will quit agricultural activities and the sign is already seen in Rajshahi District where agricultural land is transformed into mango garden.

4.2 Net Returns

The allocation of farm resources does not mean only the change in the cropping pattern, but also to maximize the net returns of farmers. The farmer is more interested to continue his farming business and hence he should be able to get at least what he spends. The net return over variable cost of an activity or crop process was determined by deducting the variable cost from the corresponding gross income and dividing the result by variable cost and expressing it in percentage. It can be seen in Table-2 that the net return of Boro paddy is high compared to Aman Paddy of all categories of farms. But the production cost is almost the same for the production of Boro and Aman paddy. We have a clear insight from the result that the net return from animal power using farm is higher than power (power tiller/tractor) using and pooled farms since the net return from animal power using farms is 44.01% whereas the net return from power using and pooled farm are 40.51% and 43.34%, respectively, in the case of Boro paddy. The net return of Aman paddy from pooled farm is very much less compared to power and animal operated farms.

Table 2 : Net Return over Variable Cost under Existing Plans on the Sample Farms

Crops	Total Return	Variable Cost	Return Over Variable Cost	Net Return (%)
Boro (power)	45331.58	32261.85	45331.58 32261.85	40.51%
Boro (animal)	47146.25	32738.10	47146.25 32738.10	44.01%
Boro (pooled)	46407.95	32376.32	46407.95 32376.32	43.34%
Aman (power)	35122.50	27722.10	35122.50 27722.10	26.69%
Aman (animal)	32740.00	26517.33	32740.00 26517.33	23.47%
Aman (pooled)	32685.00	29413.85	32685.00 29413.85	11.12%

Source: *Author's Own Calculation*

In the last few years the market price of rice has not increased on the one hand but on the other side the input cost has increased so much. Labour, fertilizer and irrigation cost has increased remarkably and due to lack of sufficient rain in the rainy season farmers have to irrigate their Aman paddy through power pump, which increased the production cost. Among three categories of farms, the net return from Aman paddy is the lowest in pooled farm since the labour and tillage cost is very high compared to power and animal using farms. Another reason of this low rate of return is that the total return is also minimal of the pooled farm.

4.3 Inputs Productivity

Agricultural productivity is most often assessed by measures of crop yield. These measures are expressed as product per unit of land, labour, fertilizer, seed, insecticide, tillage and irrigation.

The resource productivity of important crops grown on different categories of farms is examined with the help of Cobb-Douglas production function. Hence, Log-Linear regression equation was estimated through ordinary least squares method where the human labour, fertilizers, tillage, irrigation, seed and insecticide were regressed upon yield. Production function on per acre basis is estimated for Boro and Aman paddy. The estimated regression coefficients are presented in Table 3. It is observed in the table that the inputs, namely human labour, fertilizers, seed, insecticides, irrigation and tillage were jointly responsible for explaining about 16 to 57 percent variations in the yield of Boro and Aman paddy in three categories of farms. In the case of log linear Cobb-Douglas type of production function, the estimated parameters gave the production elasticity of factors included in the model. The elasticity of an input indicates the percentage increase/decrease of the quantity of that input with a specified level of other inputs.

The coefficients of partial elasticity of the production of all six inputs (human labour, fertilizers, tillage, irrigation, seed, and insecticides) were less than unity with positive signs at all the levels of mechanization implying diminishing marginal productivity of input factors. In other words, by holding the other inputs constant at their geometric mean level, and increasing any of them, the yield would increase at a diminishing rate. The coefficients of partial elasticity of the production of inputs were greater or less than unity. The negative sign of the coefficients indicates that an increase in these inputs will have negative impact on total production of crops.

The intercepts of the estimated equations are positive in the case of Boro and Aman paddy on power, animal and pooled farms.

4.4 Productivity of Human Labour

It has been seen from Table-3 that the use of human labour in the crop production process is statistically significant in Aman Paddy under animal operated and pooled farms. The effect is significant at 10% and 5% level in Aman Paddy in animal operated and pooled farms, respectively. These results indicate that by increasing human labour it would be possible to change the returns of Aman Paddy of all farms especially in the animal operated and pooled farms. In the case of power operated and pooled farms human labour has a positive impact on Boro production, which means, if the farmers increase one percent of human labour, the output will increase 0.08 and 0.09 percent respectively. The output of Aman paddy will increase 0.03, 0.21 and 0.48 percent, if the use of human labour will increase by one percent in power operated, animal operated and pooled farms, respectively.

Table 3 : Production Functions of Selected Crops on Power Operated, Animal Operated and Pooled Farms in Rajshahi District

Variables (in terms of log)	Power Operated Farm		Animal Operated Farm		Pooled Farm	
	Boro	Aman	Boro	Aman	Boro	Aman
Constant	1.6317	1.184	2.374	2.29	2.466	1.042
Human Labour	0.085	0.026	-0.060	0.211***	0.094	0.479*
	(0.099)	(0.269)	(0.059)	(0.131)	(0.158)	(0.206
Fertilizer	0.235**	0.148	0.010	-0.103	-0.658	0.123
	(0.100)	(0.102)	(0.049)	(0.080)	(0.370)	(0.269
Tillage	0.039	0.331	-0.088	0.048	-0.252	0.224
	(0.025)	(0.237)	(0.066)	(0.077)	(0.251)	(0.507
Irrigation	0.207	0.076	0.008	-0.001	0.411***	-0.639
	(0.148)	(0.109)	(0.079)	(0.042)	(0.209)	(0.936
Seed	-0.013	-0.214	0.090**	-0.218	0.430***	0.276
	(0.101)	(.168)	(0.039)	(0.078)	(0.259)	(0.190
Insecticides	0.107	0.542**	0.062	0.079***	-0.073	-0.087
	(0.105)	(0.223)	(0.044)	(0.047)	(0.124)	(0.103
R^2	0.562	0.535	0.168	0.217	0.420	0.374
F Value	2.569	2.496	1.778	1.766	1.808	1.295
Returns to Scale	0.660	0.909	0.022	0.016	0.098	0.376

Source: *Author's Own Calculation;*1% level of Significance ** 5% level of Significance *** 10% level of significance; Figures in the parenthesis show standard error of the respective co-efficient*

The insignificant effect of the use of human labour on output has been found in the case of Boro paddy in animal operated farms. The regression coefficient -0.060 indicates that for one percent increase of human labour in Boro paddy under power tiller operated farm the output will decrease by 0.060 percent.

The comparison of elasticity coefficients of the use of human labour in different categories of farms shows that in the production of Aman paddy, the elasticity of human labour coefficient is very high in pooled farms followed by the production in animal operated farm. It indicates that the increase of output will be maximized in the pooled farms by increasing the use of human labour on such farms.

4.2 Productivity of Fertilizers

The production elasticity coefficients of fertilizers are statistically significant at 5% level in the case of Boro paddy in power operated farms. In the same kind of farms, fertilizer has positive impact in the production of Aman Paddy and if we increase one percent use of fertilizer, output will increase around 0.15 percent. The regression coefficient - 0.658 indicates that by increasing one percent fertilizer, the production of Boro in pooled farms will decrease by - 0.658 percent. The negative impact is also found in the production of Aman Paddy production under power tiller operated farms.

The comparison of elasticities of coefficient of Boro and Aman paddy which are produced in the three categories of farm shows the maximum return by increasing one percent use of fertilizer. Thus, the maximum return comes from Boro paddy followed by Aman paddy in power operated farms.

4.3 Productivity of Tillage

Though the use of tractor has positive impact on the production of Boro and Aman paddy, the elasticities of coefficients are not statistically significant. If the farmers will increase one percent of tillage, the output of Boro and Aman paddy will increase by 0.04 and 0.33 percent, respectively. Using power tiller/tractor has negative impact on the production of Boro paddy but has positive impact on the production of Aman paddy. The same result is found in the case of pooled farms.

If we compare the elasticities of coefficients of the use of tillage between Boro and Aman paddy then it is found that the coefficient of Aman Paddy is higher than Boro Paddy in power operated farm. In the case of Aman Paddy tillage has a positive impact in power operated, animal operated and pooled farms and the elasticities of coefficient are higher in power operated farms in Aman paddy than animal operated and pooled farms.

4.4 Productivity of Irrigation

Table 3 has shown that the production elasticities of coefficient of irrigation are statistically significant in Boro paddy under pooled farms and the effect is significant at 10 percent level. The irrigation has positive impact on the production of Boro and Aman paddy under power operated farms. The negative impact is found in Aman paddy under animal operated and pooled farms. The comparison of the elasticities of coefficients of the use of water resource in the production of Boro and Aman paddy under three categories of farms has shown that the maximum return comes from Boro Paddy under pooled farms by increasing one percent of irrigation.

4.5 Productivity of Seed

It has been seen from Table-3 that the seed has significant effect at 5 percent level in Boro production under animal operated farms and at 10 percent level under pooled farms. The seed has positive impact on Aman paddy under pooled farms but it is not statistically significant. The negative impact has been found in both Boro and Aman paddy under power operated farms. The comparison of elasticities of coefficient of the use of Boro and Aman seeds under different categories of farms has shown that in Boro paddy the elasticities of coefficient are maximized in pooled farms followed by Aman paddy under the same farms. This indicates the fact that the increase in the production of Boro paddy will be maximized in the pooled farms by increasing the use of seed.

4.6 Productivity of Insecticides

The elasticities of coefficients with respect to insecticides are statistically significant at 5 percent level in Aman Paddy under power operated farms and at 10 percent level in animal operated farms. The insecticides have positive impact on Boro paddy in both power and animal operated farms but the effect is not statistically significant. The negative impact has been found in both Boro and Aman paddy under pooled farms which means that by increasing one percent of insecticides the output will decrease by 0.07 and 0.09 percent respectively. If we compare the elasticities of coefficients of different crops under different categories of farms then it has been seen from Table 3 that the maximum return comes from Aman paddy under power operated farms.

4.7 Returns to Scale

The returns to scale explain the behavior of change of yield when all inputs are changed simultaneously in the same proportion. This is indicated by the sum of individual elasticity coefficients of factors includes in the Cobb-Douglas production function. Increasing, constant or decreasing returns to scale are said to exist accordingly, as the sum of coefficients is greater than, equal to or less than unity. Based on this criterion, it has seen from Table-3 that the sum of the elasticity of the factors is not greater than one which indicates that there is no increasing returns to scale in the case of Boro and Aman paddy in power, animal and pooled farms. Irrespective of the crops, returns to scale of all the crops is less than unity indicating the decreasing returns. Put in another way, a unit increase of these factors would result in diminishing returns in such cases. However, there are a few inputs, which are contribute significantly to the yields. So it is possible to increase the returns by using more inputs.

5. Summary and Recommendations

The study has examined the impact of mechanization on Boro and Aman paddy production, profitability of rice farming and marginal productivity of inputs such as labour, tillage, irrigation, seeds, fertilizers and insecticides. The empirical results of profit function show that the profit margin of Boro paddy is higher than Aman paddy under power, animal operated and pooled farms. There is no significant difference in the profit margin of Boro paddy under three categories of farms but there is a variation in the profit margin of Aman paddy under the same farms. Among these, the profitability of Aman paddy in pooled farm is very low compared to other mechanized such as power and animal using farms. Though farm mechanization reduces the number of workers needed per acre or reduces per acre labour cost, the present increasing trend of labour wage outweighs the labour cost. So, per acre average labour cost is almost the same in mechanized and non-mechanized farms. The tillage cost in pooled farm is high compared to mechanized farms since the cost of tillage by draught power has increased very much and more number of tilling is needed if farmers use both methods. The difference between gross return of Boro and Aman paddy is very high compared to the difference between inputs cost of these two crops. There is no big difference among the net returns of Boro paddy in mechanized and non-mechanized farms. On the other hand, the net returns of Aman paddy in pooled farm is very low compared to the power and animal operated farms because the variable cost is very high and the per acre yield is very low.

From the results of the production function it is seen that the values of coefficient of determinations are quite low and most of the independent variables are not significant but have positive impact on output in the case of Boro and Aman paddy under three categories of farms. As it is seen from the results of regression analysis, most of the independent variables have negative impact on output in Boro and Aman paddy under animal and pooled farms.

The findings of the study show that the profits of Boro and Aman paddy are very low due to high input costs and low market price and also the inputs are not used properly under the three categories of farms. So, it is advisable for the farmers to adopt new technologies in their farms to reduce the number of hired human labour, which will not only reduce tilling cost but also reduce planting, weeding, harvesting and threshing cost. Specialize as well as commercial banks must ensure agricultural loans to buy modern technologies such as tractor, power tiller, thresher, fertilizers etc. More importantly, for spreading modern technologies among marginal farmers government can provide expensive machineries such as tractor, power tiller, deep tube well and harvesting machine through co-operative society. Because of the lack of knowledge and proper training, farmers do not apply fertilizers and pesticides in right doses. To overcome these problems, government should take proper steps to spread education and training among farmers through agricultural extension programs. To expand irrigation facilities in the study area government should take new projects through Barind Multipurpose Development Authority. Finally, to save farmers from ruin and increase the profit margin, it is very much necessary to reduce fertilizers and diesel prices in one hand; and on the other hand government must ensure the fair market price of rice.

References

1. Ahmad, B. (1983). "Implications of farm mechanization for employment, productivity and income". *Agricultural mechanization in Asia, Africa and Latin America,* 14(2): 65-68.
2. BBS. (2012). *Statistical Year Book of Bangladesh*. Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, Government of the People's Republic of Bangladesh.
3. Majumdar, M.K., Majumdar, L. and Roy, P.C. (2009). *Journal of Bangladesh Agricultural. University*, 7(2): 247–252, 2009 ISSN 1810-3030.
4. Mendoza, T.C. (2002). **"**Comparative productivity, profitability and energy use in Organic, LEISA and Conventional rice production in the Philippines". *Livestock Research for Rural Development* 14 (6) 2002.
5. Noman, A.N.K., Joarder, S. (2011). "Agricultural Transformation, Climate Change and Issue of Food Security in Bangladesh". *Bangladesh Economics Studies,* Volume 13, June 2011, PP (139-168).
6. Sidhu, K.S. and Grewal, S.S. (1990). "Factors affecting demand for human labour in Punjab agriculture: An economic analysis", *Indian Journal of Agriculture Economics,* 45(2) : 125-133.
7. Sharma, G. P., Sharma, B.M. Singh, Iqbal (1991). "A comparative study of income and employment of tractor and bullock operated farms in Chanausi block of Aligarh district, Uttar Pradesh". *Agricultural Situation in Indai,* Oct : 531-536.

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 189-209
Bangladesh Economic Association
(ISSN 2227-3182)

Impact of Education on Rice Production in the Northern Districts of Bangladesh: A Ridge Regression Analysis

Md. Sariful Islam*
Kazi Julfikar Ali**
M. Moazzem Hossain Khan***

Abstract *This study examines the impact of education on rice production in the northern districts of Bangladesh. The study employed farm level cross sectional data from the village of Chapachil of Shibganj Upazila of Bogra. The data used were collected by employing random sampling technique. The chi-square test and the econometric techniques of ordinary least squares (OLS) and ridge regression methods are used to access the impact of education on rice production. The results of the study show that education has a statistically significant and positive effect on rice production. The study also shows that input cost, labour cost, cultivable land and extension service have statistically significant and positive effect on rice production. The policy suggestion of the study is that government should put emphasis on education through literacy campaign, training and adult education programs so that rice production is increased. In addition, government should take initiative so that the farmer can easily adopt modern agricultural inputs.*

1. Introduction

Farmer's education is an important factor of rice production. Educated farmers can catch up new technology as well as modern inputs rapidly. Rice is the main

* M. Phil. Fellow, Institute of Education and Research (IER), University of Rajshahi, Bangladesh
** Assistant Professor, Department of Economics, University of Rajshahi, Bangladesh
*** Professor and Chairman, Department of Economics, University of Rajshahi, Bangladesh

and most dominant food crop. It provides 47.5 percent of rural employment (Bangladesh Economic Review, 2013). More than 95% of population consume rice and it alone provides 76% of calorie and 66% of total protein requirement of daily food intake (Bhuiyan *et al.,* 2002). About 77% area of arable land is used for rice production of Bangladesh (IRRI, 2012). Bangladesh needs to import rice almost every year as it faces a deficit of rice. In 2011-12 FY, the total import of rice through public and private sectors was 5.23 lakh metric tons (Bangladesh Economic Review, 2012). This deficit can be overcome by enhancing the productivity of rice. Rice productivity can be obtained both through technological improvement and efficiency improvement. Most of the farmers in our country are illiterate and live on subsistence farming. As a result, their income level is very low compared to other developing countries. So, it is difficult for them to gear up their income without education. Owing to lack of work-based education, the education arena has not so developed in Bangladesh. Although rice production is the main stream of her economy, education for scientific method of rice production is still felt necessary in this country. Education is an indispensable element for economic and social progress (Dev et al.1995). Most of the people live in rural areas and maintain their livelihood from the cultivation of rice. Rice cultivation also provides a safety net for the poor. Given the importance of rice in Bangladesh, this study focuses on the impact of education on rice production.

1.2 Review of Literature

A number of studies have assessed the relation between education and agricultural production (Wu, 1977; Lockheed et al.,1980; Jamison & Lau,1982; Philips, 1987; Hassan et al., 2003; Minh-Phuong, 2006); Onphanhdala,2009;Yasmeen et al.,2011; Girgin,2011; Rehman et al.2012). A number of other studies have assessed the impact of education on agricultural production (Singh, 1974; Welch, 1970; Pudasaini, 1983). There are yet other studies that have assessed the impact of education on rice production (Asadullah & Rahman, 2006; Salehin et al, 2009; Haq, 2012; Nargis & Lee, 2013; Duraisamy, 1989) in national and international arena. Asadullah and Rahman (2006) found that the different level of education has a positive and significant effect on rice production in Bangladesh. They found that the primary and secondary level of education is more relevant in rice production than tertiary level. Salehin et al. (2009) found that the education of the farmers has a significant and positive effect on rice production in Bangladesh. They also found that educated farmers are likely to be more receptive to the modern facts and ideas. Haq (2012) showed that primary education has positive value and its impact on rice productivity is significant. He found that farmers with primary education seem effective for rise per unit of rice productivity in Bangladesh. He also found that the farmers, who have only primary school degree, might spend enough time for farm production. Nargis and Lee (2013) found that education has a statistically significant and positive effect on rice production in Bangladesh. They also found that farmers who are more educated are likely to be more efficient compared to their less-educated counterparts, perhaps because of their better skills, access to information, and good farm planning. Duraisamy (1989) found that education has a positive and significant effect on rice production in India. He found that education expands the probability of adoption of modernization in new techniques in rice production. He found that the higher level of education is required to better understand, make out new information and utilise it in an effective way. He also found that the level of using high-yielding rice varieties in India was positively related to level of education. Dominique van de Walle (2003) studied the impact of education on rice production in Vietnam. Three major results come out of that study. First, education of the household head and other family members makes a significant contribution to farm profitability. Second, there also seem to exist important complementarities between education and irrigation, thereby giving some indication that education does help Vietnamese farmers make better use of agricultural technology, and third, primary education, but not higher levels of education, has significant impact on farm profitability. Years of schooling are found to have a significant impact on rice productivity, even though it is a small one.

Most of the studies included aggregate level of education, input cost, cultivable land, family labour and extension service as explanatory variables. But most of them did not include hired labour cost. The general forms of Cobb-Douglas production function were used in most of the studies. These studies have examined the effect of education on agricultural production as well as rice production through ordinary least squares model. They did not explain the pitfalls of their model. To have a clear picture of the impact of education on rice production in the northern districts of Bangladesh, it is necessary to make a deeper enquiry. Disaggregate level of education is used as explanatory variable rather than aggregate level of education in this study. The shortcomings of the classical linear regression model have been discussed systematically in this study. As a result, the findings of the study can be expected to be more reliable and valid than other studies. In this study, the ridge regression was applied to overcome the multicollinearity problems. To our knowledge, the study is the first of its kind in Bangladesh.

The objective of this study is to analyse the impact of education on rice production in the northern districts of Bangladesh by using ridge regression. The rest of the paper is structured as follows: Methodology and data of the study is presented in Section 2. The results and discussion are presented in Section 3. Finally, summary and policy implications are presented in Section 4.

2. Methodology of the Study

2.1 Selection of the Study Area

Shibganj Upazila of Bogra district was purposively selected as the study area for the study. The Shibgonj upazila comprises of 409 villages (BBS, 2012). The villagers primarily rely on agriculture activities, of which rice is the main agricultural crop in this upzila. That is why Shibganj was selected for the study. In addition, rice production of this upazila is higher than other upazilas of Bogra district (BBS, Bogra, 2012).

2.2 Methods of Data Collection

The study was based on primary and secondary data. The primary data were collected by using a structured questionnaire. Before preparing and applying the questionnaire to the final survey, pre pilot and pilot survey were done. The pre pilot survey was carried out through the Agricultural Office of Shibganj, concerned Sub-Assistant Agriculture Officer (SAAO), and academics. The pilot survey was conducted during November to December 2012. Afterwards, the final survey was carried out during December 2012 to January 2013.

Secondary data were collected from various issues of Bangladesh Economic Review, Agriculture census, Department of Agriculture Extension (DAE), and Bangladesh Bureau of Statistics (BBS).

2.3 Sampling Technique of the Study

An up-to-date list of all farmers of the selected village were collected from Upazila Agriculture Office. The list consists of 306 farmers, which constituted the population. In this study, random sampling technique was employed to collect the data. The numbers of farm household were selected randomly by using determination of sampling formula (Krejcie and Morgan, 1970) for regression analysis. Thus, the sample size was 171.

2.4 Empirical Theory and Method

The modified model of Jamison and Lau (1982) was utilized in this study.

$$Y = AK_i^{\beta_1} L_i^{\beta_2} T_i^{\beta_3} e^{\beta_4 D_1 + \beta_5 D_2 + \beta_6 D_3 + \beta_7 D_4 + DExt + \mu_i} \qquad (1)$$

Equation (1) provides nonlinear relationship between output and inputs. So, the nonlinear relationship can be linearized by both side natural logarithms (ln). So, the fitted model of this study is as follows

$$\ln Y = \beta_0 + \beta_1 \ln K_i + \beta_2 \ln L_i + \beta_3 \ln T_i + \beta_4 D_1 + \beta_5 D_2 + \beta_6 D_3 + \beta_7 D_4 + DExt + \mu_i ....(2)$$

where,

Y_i = total output of rice, K_i = input cost, L_i = labour cost ,T_i = cultivable land
D_1 = 1primary education of the farmer
= 0 otherwise
D_2 = 1secondary education of the farmer
= 0 otherwise
D_3 = 1 higher secondary education of the farmer
= 0 otherwise
D_4 = 1 tertiary education of the farmer
= 0 otherwise
Ext = extension service
D = 1 if taken extension service
D = 0 otherwise
μ_i = error term

The error term is assumed random and serially independent having zero mean with finite variance. In order to determine the appropriate technique of estimation, the empirical model is estimated by the ordinary least squares (OLS) method.

2.5 Definition of the Variables and Research Hypothesis

Output

Output is defined as the physical output of rice per decimal. Physical output is defined as the total production of rice cultivated area. It is expressed in terms of kilogram per decimal.

Input Cost

Input cost is defined as the sum total of expenditures on seeds, seedbed preparation, plough units, irrigation, organic and inorganic fertilizers, insecticides, fungicides, herbicides, harvesting and threshing cost.

Null hypothesis H_0: There is no relation between input cost and rice production.

Alternative hypothesis H_1: There is a relation between input cost and rice production.

Labour Cost

Labour unit is measured in man-days of eight hours. There are two types of labour cost in rice production. One hired labour cost and another family labour cost. Labour cost consists of these two types.

Null hypothesis H_0: There is no relation between labour cost and rice production.

Alternative hypothesis H_1: There is a relation between labour cost and rice production.

Cultivable Land

Cultivable land that is used by ploughing, sowing, and raising crops is expressed as decimal.

Null hypothesis H_0: There is no relation between cultivable land and rice production.

Alternative hypothesis H_1: There is a relation between cultivable land and rice production.

Education

Year of schooling may be represented as a level of education. It is defined as the number of academic years that a person has taken his/her lesson in educational institutions in this study. Level of education can be divided into five categories. These are illiterate, primary, secondary, higher secondary and tertiary.

Null hypothesis H_0: There is no relation between education and rice production.

Alternative hypothesis H_1: There is a relation between education and rice production.

Illiterate

People who can neither read nor write are be defined as illiterate. Illiterate also refers to someone who has not had any formal education at all.

Null hypothesis H_0: There is no relation between illiterate person and rice production.

Alternative hypothesis H_1: There is a relation between illiterate person and rice production.

Primary Education

Primary education consists of five years of formal schooling. Person who obtained primary education from a formal or informal school is called primary educated person.

Null hypothesis H_0: There is no relation between primary education and rice production.

Alternative hypothesis H_1: There is a relation between primary education and rice production.

Secondary Education

The secondary level of education comprises of five years of formal schooling.

Null hypothesis H_0: There is no relation between secondary education and rice production.

Alternative hypothesis H_1: There is a relation between secondary education and rice production.

Higher Secondary

The higher secondary level of education is comprised of two years of formal education.

Null hypothesis H_0: There is no relation between higher secondary education and rice production.

Alternative hypothesis H_1: There is a relation between higher secondary education and rice production.

Tertiary Education

Tertiary education is defined as people who hold education more than higher secondary level. Tertiary education is normally taken to include undergraduate and postgraduate education as well as vocational education and training.

Null hypothesis H_0: There is no relation between tertiary education and rice production.

Alternative hypothesis H_1: There is a relation between tertiary education and rice production.

Extension Service

The contact between agriculture extension agents or officers and farmers is introduced as a measure of the availability of information about new and improved inputs. It is measured in dummy variable.

Null hypothesis H_0: There is no relation between extension service and rice production.

Alternative hypothesis H_1: There is a relation between extension service and rice production.

2.6 Regression Analysis

As the main objective of this study is to assess the impact of education on rice production, for achieving this objective cause-effect analysis is suitable. In doing so, regression analysis has been applied in this study. Regression analysis has become one of the most widely used statistical tools for analyzing multifactor data. It is appealing because it provides a conceptually simple method for investigating functional relationship among variables.

2.6.1 Ridge Regression

Ridge regression provides another alternative estimation method that may be used to advantage when the predictor variables are highly intercorrelated. There are a number of alternative ways to define and compute ridge estimates. Ridge estimates of the regression coefficients may be obtained by solving a slightly altered form of the normal equations. Hoerl and Kennard (1970) suggested the ridge regression as an alternative procedure to the OLS method in regression analysis, especially, when multicollinearity exists.

The addition of a small positive number k to the diagonal elements of XX causes XX to be non-singular. Therefore, the ridge solution is given by:

$$\hat{\beta}_R = (X'X + kI)^{-1} X'Y, k \geq 0 \qquad (3)$$

Where k is ridge parameter and I is identity matrix. Values of k lie in the range (0, 1). When k = 0, the ridge estimator becomes as the OLS.

From equation (3), by taking expectation on both sides, $E(\hat{\beta}_R) = A_k \beta$

where $A_k = \left[I + k(X'X)^{-1}\right]^{-1}$

and $Var\left(\hat{\beta}_R\right) = \hat{\sigma}^2 A_k (X'x)^{-1} A_k'$

The ridge estimator $\hat{\beta}_R = \left[I + k(X'X)^{-1}\right]^{-1}\hat{\beta}$ is a linear transformation of the OLS. The sum of the squared residuals is an increasing function of *k*. The mean squares error of ridge estimator is given by:

$$MSE\left(\hat{\beta}_R\right) = E\left[\left(\hat{\beta}_R - \beta\right)'\left(\hat{\beta}_R - \beta\right)\right] = \hat{\sigma}^2 trace\left[A_k(X'X)^{-1}A_k'\right] + \hat{\beta}'(I - A_k)'(I - A_k)\hat{\beta}$$

$$\hat{\sigma}^2 \sum_{i=1}^{p} \frac{\lambda_i}{(\lambda_i + k)^2} + k^2 \hat{\beta}'(X'X + kI)^{-2}\hat{\beta} \qquad (4)$$

Where, $\lambda_1, \lambda_2, \ldots\ldots \lambda_p$ are the eigenvalues of XX and the first term of the right hand in equation (4) is the trace of the dispersion matrix of theβ_R and the second term is the square length of the bias vector. There always exists a $k > 0$, such that β_R has smaller MSE than β_R this means $MSE\left(\hat{\beta}(k)\right) < MSE(\hat{\beta})$ that. It indicates that ridge estimator performs better than the OLS estimator. Ridge regression model provides better and valid results than ordinary least squares when the multicollinearity problem exists. This is because it has smaller MSE of estimators, smaller variance for most estimators than OLS.

3. Results and Discussion

The impact of education on rice production was examined by using descriptive and inferential statistics. *Chi square* test is applied to assess the association between level of education and rice production. Regression analysis is employed to estimate the impact of education on rice production in the study area. Both quantitative and dichotomous variables are employed as explanatory variables in this study.

3.1 Descriptive Statistics

Table 3.1 shows the variables that are used in estimations and their sample statistics, namely maximum and minimum values, mean and standard deviation.

Table 3.1 : Descriptive Statistics of the Variables

Item	No. of cultivators	Minimum	Maximum	Mean	Standard Deviation
Output (Kg)	171	1300.00	6375.00	3289.7953	1369.35948
Yield (kg)	171	18.18	24.75	22.3989	1.58658
Input cost (Tk.)	171	3550.00	18000.00	9645.5205	4312.40019
Input cost(Tk.) per decimal	171	46.98	74.81	64.9354	7.74889
Labour cost (Tk.)	171	2850.00	15500.00	7672.4269	3588.58535
Labour cost (Tk.) per decimal	171	41.13	60.98	51.3738	6.16396
Cultivable land (decimal)	171	66.00	272.00	147.6462	62.62810
Education (years of schooling)	171	.00	16.00	6.2807	4.61616
Extension service (percentage)	Yes=52.6 No=47.4				

Source: *Field survey, December 2012 and January 2013*

The mean, standard deviation, minimum and maximum of the variables are presented in Table 3.1. In Table 3.1, it is found that the average yield of rice is 22.39 kilograms with maximum average yield of 24.75 kilograms and minimum average yield of 18.18 kilograms. The average value of input cost is 64.93 Tk. with maximum and minimum average value of input cost being 74.81 Tk. and 46.98 Tk., respectively. The average value of labour cost is 51.37 Tk. and the maximum and minimum average value of labour cost are 60.98 Tk. and 41.13 Tk., respectively. The average of cultivable land is 147.64 decimal with the maximum and minimum of the cultivable land being 272 decimal and 66 decimal, respectively. The average level of education of the respondent is 6.28 years and the standard deviation of the education level of the respondent is 4.61 years. Maximum education level of the respondent is 16 years and minimum is 0.00 years. Maximum and minimum education level shows a wide variation of the respondents. About 52.6% respondents of the study area take agricultural extension service from Sub Assistance Agriculture Officers and the rest 47.4% do not take any extension service.

3.2 Results of *Chi-Square* Test

Table 3.2 : Impact of Education on Rice Production in the Study Area

Yield (kg)	Illiterate	Primary	Secondary	Higher Secondary	Tertiary	Total
18-22	28	14	18	0	2	62
22-26	0	38	46	11	14	109
Total	28	52	64	11	16	171
$\chi^2 = 63.182$ df=4	p value =0.000					

Source: *Field survey, December 2012 and January 2013*

Table 3.2 shows the impact of education on rice production in the study area. In Table 3.2, the calculated value χ^2 of is 63.182 and the critical value of χ^2 for 4 degrees of freedom at 0.1% level of significance is 18.467. Since the calculated value of is greater than the tabulated value, the null hypothesis can be rejected. So, the alternative hypothesis is accepted at the 0.01% level of significance. It can be said that there is a relationship between the two variables. So, there is evidence of a relationship between rice production and education.

Table 3.3 shows the impact of illiterate farmers on rice production in the study area. In Table 3.3, the calculated value of is 58.864 and the critical value of for 1 degrees of freedom at 0.1 % level of significance is 10.827. Since 58.864 > 10.827, the null hypothesis can be rejected, and the alternative hypothesis

Table 3.3 : Impact of Illiterate Farmers on Rice Production

Yield(kg)	Illiterate	Others	Total
18-22	28	34	62
22-26	0	109	109
Total	28	306	171
$\chi^2 = 58.864$ df=1 p value =0.000			

accepted at the 0.1% level of significance. That is to say, there is relationship between the two variables. So, there is evidence of a relationship between rice production and illiterate farmer. This is because; the experience of the illiterate farmer is higher than others.

Table 3.4 : Impact of Primary Education on Rice Production

Yield(kg)	Primary level	Others	Total
18-22	14	48	62
22-26	38	71	109
Total	52	119	171
$\chi^2 = 2.817$ df=1 p value =0.093			

Table 3.4 shows the impact of Primary education on rice production. In Table 3.4, the calculated value of is 2.817 and the critical value of for 1degrees of freedom at 10% level of significance is 2.706. Since 2.817 > 2.706, the null hypothesis can be rejected, and the alternative hypothesis accepted. It can be said that there is a relationship between the two variables. At the 10% level of significance, there is evidence of a relationship between rice production and primary education.

Table 3.5 : Impact of Secondary Education on Rice Production

Yield(kg)	Secondary level	Others	Total
18-22	18	44	62
22-26	46	63	109
Total	64	107	171
$\chi^2 = 2.927$ df=1 p value =0.087			

Table 3.5 shows the impact of secondary education on rice production. In Table 3.5, the calculated value of is 2.927 and the critical value of for 1 degrees of freedom at 10% level of significance is 2.706. Since 2.927 > 2.706, the null hypothesis can be rejected, and the alternative hypothesis accepted. It can be said that there is a relationship between the two variables. At the 10% level of significance, there is evidence of a relationship between rice production and secondary level of education.

Table 3.6 : Impact of Higher Secondary Level of Education on Rice Production

Yield(kg)	Higher Secondary Level	Others	Total
18-22	0	62	62
22-26	11	98	109
Total	11	160	171
$\chi^2 = 6.687$ df=1 p value = 0.010			

Table 3.6 shows the impact of higher secondary education on rice production. In Table 3.6, the calculated value of is 6.687 and the critical value of for 1 degrees of freedom at

1% level of significance is 6.635. Since 6.687 > 6.635, the null hypothesis can be rejected, and the alternative hypothesis accepted at the 1% level of significance. That is to say, there is a relationship between the two variables. So, there is evidence of a relationship between rice production and higher secondary level of education.

Table 3.7 : Impact of Tertiary Level of Education on Rice Production

Yield(kg)	Tertiary level	Others	Total
18-22	2	60	62
22-26	14	95	109
Total	16	155	171
$\chi^2 = 4.311$ df=1 p value =0.038			

Table 3.7 shows the impact of tertiary level education on rice production in the study area. In Table 3.7, the calculated value of is 4.311 and the critical value of for 1 degrees of freedom at 5 % level of significance is 3.841. Since 4.311 > 3.841, the null hypothesis can be rejected, and the alternative hypothesis accepted at the 5% level of significance. That is to say, there is a relationship between the two variables. So, there is evidence of a relationship between rice production and tertiary level of education.

3.3 Empirical Results

The empirical results of the production function in equation (2) are presented in Table 3.8.

In Table 3.8, the findings show that the input cost of production is insignificant and the coefficient of input cost of production is 0.032771. The result indicates that as input cost of production increases by Tk.1, output increases by

Table 3.8 : Empirical Results of Multiple Regressions

	β	St. Error	t	P value	Eigenvalue	Tolerance	VIF
1	2	3	4	5	6	7	8
Intercept	2.847009*	0.0648	43.88	0.0000	5.4638	-	-
Input cost(k)	0.032771	0.0282	1.15	0.2482	1.0169	0.019984	50.039
Labor cost(L)	0.027	0.0290	0.93	0.3536	1.0000	0.018422	54.282
Cultivable Land(T)	0.915301*	0.0178	51.36	0.0000	1.0000	0.059205	16.890
Primary(D_1)	0.119952*	0.0062	19.24	0.0000	0.4138	0.413936	2.4158
Secondary(D_2)	0.130672*	0.0061	21.22	0.0000	0.1017	0.383374	2.6084
Higher Secondary(D_3)	0.129498*	0.0095	13.59	0.0000	0.0034	0.622866	1.6054
Tertiary(D_4)	0.147132*	0.0082	17.81	0.0000	0.0001	0.588664	1.6987
Extension Service(S)	0.059834*	0.0044	13.52	0.0000	0.00002	0.697991	1.4326
R^2		0.9968					
Adjusted R^2		0.9967					
Mean square error		24.62					
d Statistic (DW)		2.027					

Source: *Field survey, December 2012 and January 2013; * Highly significant*

0.032771kilogram. The labour cost of production is statistically insignificant. The coefficient of labour cost of production is 0.027. The result indicates then if the labour cost of production increases by Tk.1, then the total output increases by 0.027 kilogram. The cultivable land is statistically highly significant. The coefficient of cultivable land is 0.915301.The result indicates that it the cultivable land increases by 1 decimal, total production increases by 0.915301kilogram per decimal.

The coefficient of illiterate farmer is 2.847009, which is highly significant. This is because, if the farmers' experience increases, their total output increases. In this study, the level of experience is the highest for illiterate rice farmers. The coefficient of primary education is (2.847009+0.119952) = 2.966961, which is highly significant. It indicates that if the primary education of farmer increases, their total output increases by 2.966961 kilogram. The coefficient of secondary education is (2.966961+0.130672) =3.097633, which is highly significant. If the secondary education of farmers increases, their total output increases by 3.097633 kilogram. The coefficient of higher secondary education is (3.097633 +0.129498) =3.227131, which is highly significant. If the higher secondary education of farmer increases, their total output increases by 3.227131kilogram. The coefficient of tertiary education is (3.227131+0.147132) =3.374263, which is highly significant. If the tertiary education of farmer increases, their total output increases by 3.374263 kilogram. The coefficient of extension service is 0.059834 and it is statistically significant. It indicates that if the extension service increases, the farmers' total output increases by 0.059834 kilogram.

Two variables of this model provide insignificant results. So, this model might suffer from multicollinearity problem. In Table 3.8, the value of *d* statistic is 2.027, which indicates that there is no serial correlation.

3.4 Reliability and Validity

To ensure the reliability of the questionnaire Cronbach's alpha test has been used in this study. The result of Cronbach's alpha test is given in Table 3.9.

Table 3.9: est of Reliability

Number of observation	Number of items	Standardized item Alpha	Cronbach`s Alpha
171	6	0.8062	0.8429

Table 3.10 : Empirical Results of Ridge Regression

	$\hat{\beta}$	St. Error	t	P value	Tolerance	VIF
1	2	3	4	5	6	7
Intercept	1.715819*	0.190249	9.018802	0.000	-	-
Input cost(K)	0.222939*	0.039048	5.709343	0.000	0.217717	4.593127
Labor cost(L)	0.224985*	0.038826	5.794679	0.000	0.213802	4.677222
Cultivable Land(T)	0.44686*	0.039804	11.22639	0.000	0.246412	4.05825
Primary (D1)	0.072477*	0.022547	3.214494	0.001	0.657046	1.521962
Secondary (D2)	0.084083*	0.022021	3.818307	0.000	0.622419	1.606635
Higher Secondary(D3)	0.060732***	0.036708	1.654468	0.099	0.871558	1.147371
Tertiary (D4)	0.101578*	0.031483	3.226416	0.001	0.840842	1.189284
Extension Service	0.050183**	0.017467	2.873032	0.004	0.929315	1.076061
R^2	0.9670					
Adjusted R^2	0.9351					
Mean square error	2.20					
k(Ridge parameter)	0.13000					

Source: *Field survey, December 2012 and January 2013*

* Highly significant **5% level of significant***10% level of significant

In Table 3.9, it is observed that Cronbach`s alpha is 0.8429, which indicates a high level of internal consistency for our scale with this specific sample.

In this study, variables and questions are drawn from literature, which ensured the validity of the questionnaire (Ali and Noman, 2013).

3.5 Results of Ridge Regression

Ridge regression has been applied to overcome the problem of multicollinearity. The ridge regression results are shown in Table 3.10.

All VIF values are less than 5 which is shown in Table 3.10. These results indicate that this model is free from multicollinearity problems. It also shows the different results between Table 3.8 and Table 3.10. All variables are statistically significant in Table 3.10.

The coefficient of input cost of production is 0.222939 and it is statistically highly significant. The results indicate that as input cost of production increases by Tk.1, output increases by 0.222939 kilogram. The same results in line with Appleton & Balihuta (1996) and Weir (1999).

The coefficient of labour cost of production is 0.224985 it is statistically highly significant. The results indicate that if the labour cost of production increases by Tk.1, then output increases by 0.224985 kilogram. The findings were consistent with studies by Cotlear (1986), Appleton & Balihuta (1996), Yang (1997) and Weir (1999).

The coefficient of cultivable land is 0.44686 and is statistically highly significant. The result indicates that it the cultivable land increases by 1 decimal, total production increases by 0.44686 kilogram per decimal. The same results were found by Cotlear (1986), Appleton & Balihuta (1996), Yang (1997), Weir (1999) and Rehman et al. (2012).

The coefficient of illiterate farmer is 1.715819, which is highly significant. This is because, if the farmers experience increases, their total output increases. In this study, the level of experience is high of illiterate rice farmers.

The coefficient of primary education is (1.715819 +0.072477) = 1.788296, which is significant. It indicates if the primary education of farmer increases, their total output increases by 1.788296 kilogram. The similar results were found by Singh (1974), Dominique van de Walle (2003),Onphanhdala (2009) and Haq(2012).

The coefficient of secondary education is (1.788296+0.084083) =1.872379, which is highly significant. If the secondary education of farmer increases, their total output increases by 1.872379 kilogram. The similar results were found by Singh (1974) and Asadullah & Rahman (2006).

The coefficient of higher secondary education is (1.872379+ 0.060732) =1.933111, which is significant. If the higher secondary education of farmer increases, their total output increases by 1.933111 kilogram. The similar result was found by Pudasaini (1983).

The coefficient of tertiary education is (1.933111 + 0.101578) =2.034689, which is highly significant. If the tertiary education of farmer increases, their total output increases by 2.034689 kilogram. The similar results were found by Pudasaini (1983) and Gemmell (1996).

The coefficient of extension service is 0.050183 and it is statistically significant. The results indicate that as the extension service increases, total production increases. This means that greater extension contacts between extension agents and farmers lead to higher productivity. Similar results were found by Huffman (1974), Haq (2011) and Nargis & Lee (2013).

3.6 Fit of the Model

The analysis of variance of ridge regression in Table 3.11 summarizes how much of the variance in the data (total sum of squares) is accounted for by the factor effect (factor sum of squares) and how much is random error (residual sum of squares). In Table 3.11, F value is 291.9985 and the overall results are highly significant.

Table 3.11 : Analysis of Variance of Ridge regression

	Sums of Squares	df	Mean Squares	F	P value
Regression	28.23563	8	3.529454	291.9985	0.000
Residual	1.958131	162	0.012087		
Total	30.19376	170			

We have tried to justify that ridge regression is better than OLS method. Table 3.8 shows the results of OLS. In Table 3.8, coefficient of determination (R-square) is 0.9968, adjusted R^2 is 0.9967. The 2nd column of Table 3.8 shows the OLS estimator of, Eigen values shown in column 6th, and VIF is in column 8th. Here maximum VIF is 54.282, which indicates greater multicollinearity. We also see that R-square and adjusted R-square are very high, and least squares estimates are unstable. The predictor variables are correlated so we can apply ridge regression techniques to find a stable set of correlation.

Table 3.10 shows the results of Ridge Regression. In Table 3.10, the coefficient of determination(*R*-square) is 0.9670, adjusted R^2 is 0.9351, 2nd column shows the ridge estimator of, VIF is in column 7th.We also see that *R*-square and adjusted *R*-square are less than OLS, and ridge estimates are stable than OLS estimates.

We also find from Table 3.8 and Table 3.10, Than the tolerance of OLS estimates is less than the tolerance of ridge estimates. As a result, the VIF for ridge estimates is less than the VIF for OLS estimates. These results indicate that the ridge regression method is better than OLS as it is clear from Table 3.8 and Table 3.10.

We estimate using OLS estimator and estimate using ridge estimator with different choices of *k* from a grid (0.01, 0.02..., and 0.13). We compute mean square error for OLS estimator and mean square error for ridge regression estimator. In Table 3.8 and Table 3.10 MSE for OLS is greater than the MSE for ridge regression. This result indicates that ridge estimator performs better than the OLS estimator does.

4. Conclusions and Policy Suggestions

In this study, *Chi Square* test has been used to find out the association between yield of rice and level of education. The results show that there is a significant association between yield of rice and the level of education. The empirical analysis of impact of education on rice production in Bangladesh is discussed in this study. Impact of education on rice production is very important for policy formulation and strategies for the development of agriculture sector. In this study, multiple regression model and ridge regression model have been used to estimate the impact of education on rice production. In addition, the empirical findings of the multiple regressions show that most of the variables are highly involved in multicolinearity. In order to overcome this problem ridge regression has been used in this study. The empirical results of ridge regression reveal that the various levels of education have positive and statistically significant effect on rice production. Therefore, the rice production increases with the increases in the level of education of farmer. This result suggests that the level of education of farmer has positive effect on rice production. The input cost of production has positive effect on rice production. The labour cost, cultivable land and extension service have also positive effect on rice production. It is to be noted that the ridge regression models turn out better results than ordinary least squares method it the multicollinearity problem prevails in the model in the sense of smaller MSE of estimators, smaller variation for estimates.

The positive impact of education on rice production supports the hypothethis that education is indeed one of the key ingredients that enhances the productivity of rice. To boost up rice production in Bangladesh government should put emphasis on education so that the farmer can easily adopt modern agricultural inputs, pest and irrigation management. The literacy campaign, training and adult education programs should be undertaken so that the farmers become better off in short run as well as in long run.

Findings of the study confirm that most of primary educated people in the study area are involved in rice production. But there is no agro-oriented course or curricula in the Primary level schools or institutions. There are a few agricultural training institutions in our country. Agro based courses must be included in the primary level schools or institutions. In addition, the number of agricultural institutes must be increased throughout the country, which in turn will increase the number of people with agricultural knowledge. It certainly would have a positive impact on agricultural productivity.

At present in the secondary level an optional agricultural science subject or course is offered which in our view is very inadequate. Therefore, a compulsory course should be introduced in the secondary and higher secondary levels. We believe it will be help increase the number of people with agricultural knowledge. For agricultural technological development, emphasis should be given on research and development activities. For that purpose, setting up agricultural universities and research institutes should be given emphasis. Policy makers may need to consider other levels of education and training in formulation of policy, for example, undertaking training programmes on the production of crops, storage of crops, pest control and management, livestock rearing, development of indigenous skills, and changing food habit, all of which can contribute to enhancing food security in the country.

References

1. Ali and Noman (2013) “Determinants of Demand for Health care in Bangladesh: An Econometric Analysis,” *World Journal of Social Sciences*. Vol.3, and No.6. November. Issue. Pp.153-163.
2. Appleton, S. and Balihuta, A. (1996) “Education and Agricultural Productivity : Evidence from Uganda”, *Journal of International Development* : Vol.8, No.3, 415-444.
3. Asadullah, M .Niaz. and Rahman, Sanzidur, (2006). **“**Farm Productivity and Efficiency in Rural Bangladesh: The Role of Education Revisited”, Contributed paper prepared for presentation at *the*. *International Association of Agricultural Economists Conference, Gold Coast*,
4. B.B.S. (2012) Population and Housing Census 2011. National Volume, *Bangladesh Bureau of Statistics* (BBS). Planning Division, Ministry of Planning; Government of the People’s Republic of Bangladesh.
5. Bhuiyan, N. I., D. N. R. Paul and M. A. Jabber (2002) Feeding the extra millions by 2025– Research and Challenges for rice research and extension in Bangladesh, National Workshop on Rice
6. Extension in Bangladesh, *Bangladesh Rice Research Institute*, Gazipur, 29-31 January.
7. Cotlear, D. (1986) “Farmer Education and Farm Efficiency in Peru : The Role of Schooling, Extension Services & Migration. Education Policy Division”, *Education and Training Departmen,* December, The World Bank.
8. Dev, U.K. and M. Hossain. (1995). “Farmers’ Education, Modern Technology and Technical Efficiency of Rice Growers”. *Bangladesh Journal of Agricultural Economics*. Vol. 18, No 2.
9. Duraisamy, P. (1989). “Human Capital and Adoption of Innovation in Agricultural Production : Indian Evidence”, Center Discussion Paper No.577, July, *Economic Growth Center*, Yale University.
10. GOB (2012).*Bangladesh Economic Review* 2012, Ministry of Finance, Government of the People’s Republic of Bangladesh.
11. GOB (2013). *Bangladesh Economic Review* 2013, Ministry of Finance, Government of the People’s Republic of Bangladesh.
12. Grigin, A. (2011) “The role of Education in Agricultural Productivity: The Case of Village Institutes in Turkey, 1940-1966”, *School of Economics and Management,* Lund University.
13. Hassan, Y,Z,M. Khan, S,A. and Malik, H,N. (2003) “Effect of Education of the Respondents on the Adoption of Recommended Chemical Control Measures Among the Rice of Thesile Kamoke, District Gujran Wala–Pakistan”, *International Journal of Agriculture & Biology*, Vol.4,pp.564-565.

14. Haq, A,Z,M. (2012) “Farmers Education and Farm Productivity in Bangladesh”. *Mediterranean Journal of Social Sciences,* Vol 3 (15) December.

15. Hoerl, A. E. and Kennard, R. W. (1970). “Ridge regression: biased estimation for nonorthogonal problems”. *Technometrics,* 12, pp.55-67.

16. Huffman, Wallace E. (1974). “Decision Making: The Role of Education”. *American Journal of Agricultural Economics,* 56, pp.85-97.

17. Jamison, D.T., and L.J. Lau. (1982). *Farmer Education and Farm Efficiency*. Baltimore: John Hopkins University Press.

18. Krejcie and Morgan (1970), “Determining Sample Size for Research Activities”, *Educational and Psychological Measurement, Vol. 30, pp. 607-610.*

19. Lockheed, M.E., Jamison, D.T. and Lau, L.J. (1980). “Farmer Education and Farm Efficiency: A Survey”, *Economic Development and Cultural Change*, 29 No.1, pp.37-76.

20. Nargis, F. and Lee, S,H. (2013) “Efficiency Analysis of Boro Rice Production in North-Central Region of Bangladesh”, *The Journal of Animal & Plant Science*, 23(2), pp.527-533.

21. Minh-Phuong, T. (2006). “Education and Agricultural Growth in Vietnam”, *Department of Agricultural and Applied Economics*, University of Wisconsin-Madision

22. Onphanhdala. P. (2009). “Farmer Education and Rice Production in Lao PDR”, *Journal of International Cooperation Studies*, Vol.16. No.3.

23. Phillips, M,J. (1987) “A Comment on Farmer Education and Farm Efficiency : A Survey”, *Economic Development and Cultural Cahnge*, Vol.35, No3, pp.637-641.

24. Pudasaini, Som.P. (1983). “The Effects of Education in Agriculture: Evidence from Nepal”, *American Journal of Agricultural Economics*, Vol. 65, No. 3, pp.509-515

25. Rehman, U.N., Khan. J. and Tariq. M. (2012). “The impact of education on agricultural production in Khyber Pakhtunkhwa province of Pakistan (1975-2008)”. *Sarhad Journal of Agriculture*, 28(2), pp.345-352.

26. Salehin, M,M., Kabir,S.M.,Morshed.M.K. and Farid. S.K. (2009). “Socioeconomic Changes of Farmers Due to Adoption of Rice Production Technologies in Selected Areas of Sherpur District”, *Journal of Bangladesh Agricultural University*, 7(2), pp.335-341.

27. Singh, B. (1974). “Impact of Education on Farm Production”, *Economic and Political Weekly* (September), pp. A92-A96.

28. Van de Walle, D. (2003). “Are Returns to Investment Lower for the Poor? Human and Physical Capital Interactions in Rural Vietnam”. *Review of Development Economics*, 7(4), pp. 636.

29. Weir, Sharada. (1999). "The Effects of Education on Farmer Productivity in Rural Ethiopia". CSAE Working Paper 99 (7)

30. Welch, F. (1970). "Education in Production", *Journal of Political Economy*, 78, pp.35-59.

31. Wu, Craig C. (1977). "Education in Farm Production: The Case of Taiwan", *American Journal of Agricultural Economics,* 59, pp.699-709.

32. Yang, T,D. (1997). "Education in Production : Measuring Labour Quality and Management", *American Journal of Agricultural Economics*, 79, pp.764-772.

33. Yasmeen, K.Abbasian, E and Hussain, T. (2011). "Impact of educated farmer on Agricultural Product", *Journal of Public Administration and Governance,* Vol.1, No.2.

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 211-221
Bangladesh Economic Association
(ISSN 2227-3182)

Factors Affecting Farmers' Decisions on Fertilizer Use: A Case Study of Rajshahi District in Bangladesh

MD. SELIM REZA*
MD. ELIAS HOSSAIN**

Abstract *This study presents empirical evidence to show how socio-economic factors influence the extent and intensity of fertilizer adoption on rice production in Rajshahi district. A multi-stage random sampling technique was used to select 90 rice farmers from the study area. Probit and Tobit regression models were used for analysis. The results of the analysis found irrigation facility to be positively and significantly related to the extent and intensity of fertilizer adoption, while access to credit and non-farm income had an indirect relationship with adoption decision of fertilizer in Probit model. Type of land, irrigation facility and access to credit had a positive and significant influence on fertilizer use but extension service is significantly and negatively related with fertilizer adoption in Tobit model. There were no significant relationships between adoption and education, distance from market and farm income. The results have important implications for the formulation of policies and programs targeted to promotion of fertilizer use in small-scale rice production. These include improved irrigation facility, ease access to credit and extension services and developed rural infrastructures, mainly the rural road network.*

1. Introduction

Bangladesh is predominantly an agricultural country where agriculture contributes 19.42% of GDP and 45% of the labour force is dependent directly or indirectly on agriculture. At present agriculture is growing at 2.46% per annum and at the same time population is growing at 1.37% and is expected to double by

* Assistant Professor, Department of Economics, University of Rajshahi
** Professor, Department of Economics, University of Rajshahi

2025 (BBS, 2013). That means every year more than 2 million new people are added to our existing population, which indicates the need to increase the productivity of agriculture to keep pace with population growth to ensure adequate supply of food in the future. Broad agriculture and rural development sectors have been given the highest priority in order to make Bangladesh self-sufficient in food. Besides, agriculture is directly related to the issues like poverty alleviation, rise in the standard of living, and increased generation of employment. All-out efforts of the government have been there to develop the agriculture sector keeping in view the goals set in the 6th Five Year Plan, National Agriculture Policy (NAP) and Millennium Development Goals.

Bangladesh is gifted with a climate favorable for the cultivation of a wide variety of both tropical and temperate crops. Rice is the staple food for above 152.5 million population in Bangladesh and will continue to remain so in future. Boro rice is one of the major cereal food crops in Bangladesh, which contributed 56.84% to the total rice production during 2008-09, whereas Aus and Aman contributed 43.16% altogether. According to Bangladesh Bureau of Statistics (2013), the total rice production was 33.80 million metric tons in FY 2011-12, among these the production of Aus and Aman was 15.1 million metric tons and Boro was 18.7 million metric tons.

Rice production system depends on various management practices such as irrigation and fertilizer applications, crop management practices, use of new high yielding varieties and modern technologies. Fertilizer is the most important nutrient elements in soils and plays the most vital role in crop production in Bangladesh. Fertilizer application mainly depends on the soil types, growing season, irrigation applications and the cultivars used and agro-climatic conditions of the locations. Urea (Nitrogen), Triple Super Phosphate (TSP), Murate of Potash (MOP), Gypsum and Dasta (ZnSO4) are the major fertilizers applied in agricultural land in various proportions for rice production in Bangladesh (Basak, 2010).

The expansion of modern agricultural farming practices like use of High Yield Variety (HYV) together with intensified cultivation results in an increasing demand for fertilizers. The use of chemical fertilizer is on the increase with the increasing demand for food production in the country. The use of Urea fertilizer alone was the highest and very much essential for rice production. In FY 2010-11, the quantity of Urea fertilizer used was 2.66 million metric tons and the total quantity of fertilizers used was 4.12 million metric tons. In FY 2011-12, the total quantity of fertilizer used was 4.05 million metric tons (BBS, 2012). Every year huge amounts of chemical fertilizer are imported from foreign countries and the import rate is significantly higher for non Urea fertilizer. Domestic production of

Urea fertilizer covered 50% to the total demand, where as TSP (Triple Supper Phosphate) was only 10%, Gypsum was 40% and MOP (Murate of Potash) was fully imported in 2008-09 (Basak, 2010).

Due to rapid population growth and urbanization, Bangladesh has lost 0.08 million hectares of cultivable land every year and there is no way to increase food crop production by expansion of land use in agriculture. This makes the need for intensification of land use through adoption of productivity enhancing technologies such as fertilizer which is crucial for achieving food security. The use of modern agricultural inputs such as chemical fertilizers is generally low compared to the recommended amount in Bangladesh. Farmers of Bangladesh use less amount of Urea fertilizer compared to the nutrient requirement and soil fertility doses. The continuous use of the chemical fertilizers under intensive cropping systems has been considered to be the main cause for declining crop yield and environmental degradation (Basak, 2010). The development of sustainable plant nutrition and pest management strategies requires information on current use of fertilizers by farmers and factors affecting adoption of those inputs (Nkamleu and Adesina, 2000).

The objective of this paper is to determine the socio-economic factors affecting the adoption of chemical fertilizers in Rajshahi District.

2. Review of Literature

Conventional Study on how farmers adopt new technologies gives explanations of the adoption decision and its regulation of occurrence (i.e. whether near the beginning or behind schedule) essentially in relation to the decision maker's perceptual experience and innate characteristics, with 'straggler' at one end and 'innovator' at the other (Rogers, 1995). But, usually, a farmer's decision making process in regard to the adoption of new technologies is complicated. This is because farmers have several objectives (such as social security, food security, sufficient income, a secure asset and so on). And circumspectly the farmers choose 'livelihood strategies' that would help them in their pursuit of these multiple objectives with their limited available resources (Ellis, 1997; Scherr, 1995).

The conventional study of farmers' adoption also streamlines the analytical thinking of the adoption decision by its underlying assumption of the decision-process of a person. The capacity of a farm household to take decisions in relation to technology and resource use differs with respect to age, education, sex, *inter alia,* and concrete decisions can be made subject to an agreement among members of the farm household (Hassan & Fufa, 2006; Gardebroek, 2002; Jackson, 1995; Ellis, 1993). The findings of the study 'Farmers' perceptions and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa' carried by Adesina and Forson (1995), provide a strong case for future adoption studies to expand the range of variables used away from the broad socio-economic, demographic and institutional factors to include farmers' subjective perceptions of the characteristics of new agricultural technologies and the variables are ease of cooking rice varieties, varieties that have the capacity to produce tillers fast, ease of threshing and better yield performance.

Adesina and Chianu (2002) ran a study on Nigeria and found that eleven variables were significant in explaining farmers' adoption decisions. The model results show that farmer characteristics that influenced adoption included the gender of the farmers, contact with extension agents, years of experience with agroforestry and tenancy status in the village. Economic factors, proxied by village-level characteristics that condition resource use incentives, were also significant. These variables include the extent of village land pressure, extent of erosion intensity, village fuel wood pressure, importance of livestock as an economic activity in the village and the distance of the village locations from the urban centers.

3. Analytical Framework and Empirical Models of Technology Adoption

The analytical techniques employed in the analysis, were Probit and Tobit regression models. In the case of categorical dependent variables (binomial or multinomial), qualitative choice models of adoption such as the logit and Probit are usually specified. These models are commonly used to analyze situations where the choice problem is whether or not (0-1value range) to adopt a new technology. The Probit specification has advantages over logit models in small samples. The present study therefore employed a Probit to examine determinants of farmers' decision to adopt or not adopt fertilizers on rice. The Probit model specification used in this study is given by

Adoption of Fertilizer (AF) = $F(\propto +\beta x_i) = F(z_i)$ (1)

Where, AF (Adoption of Fertilizer) is the discrete adoption choice variable, *F* is the cumulative probability distribution function, *ß* is the vector of parameters*,* *x* is the vector of explanatory variables and *z* is the *Z*-score of *ßx* area under the normal curve.

The expected value of the discrete dependent variable in the Probit model conditional on the explanatory variables is given by

$$E[y/x] = 0[1 - F(\beta' x)] + [F(\beta' x)] = F(\beta') \qquad (2)$$

While the Probit model is adequate for analyzing the decision that occur over a discrete range such as yes or no, it does not handle the case of adoption choices that have a continuous value range that is truncated from below. This is the typical case for fertilizer adoption decisions where some farmers apply positive levels of fertilizer application while others have zero applications (non-adopters). Intensity of use is a very important aspect of technology adoption because it is not only the choice to use but also how much to apply that is often more important. The Tobit model of Tobin (1958) is used to handle truncated distribution dependent choice variables such as the level of fertilizer use. This study used the Tobit model specification to analyses determinants of the variation in intensity of fertilizer use by rice farmers as given by

$$AD = x\beta(z) + \sigma f(z) + \varepsilon$$

$$AD^{*}, \text{ if } AD^{*} > AD_0 \qquad (3)$$

$$O, \text{ if } AD^{*} < AD_0$$

Where AD is the standard intensity (level of application), AD_0 is the critical value adoption intensity, x, β and $F(z)$ are as defined in (1). ß is the standard error, $f(x)$ the value of the derivative of the normal curve at a given point (density function).

Adoption of agricultural technologies is influenced by a number of interrelated components within the decision environment in which farmers operate. For instance, Feder *et al* (1985) indentified lack of credit, limited access to information, aversion to risk, inadequate farm size, insufficient human capital, tenure arrangements, absence of adequate farm equipment, chaotic supply of complementary inputs and inappropriate transportation infrastructure as key constraints to rapid adoption of innovations in less developed countries. However, not all factors are equally important in different areas and for farmers with different socio-economic situations.

Socio-economic conditions of farmers are the most cited factors influencing technology adoption. The variables most commonly included in this category are age, education, household size, landholding size, livestock ownership and other factors that indicate the wealth status of farmers. Farmers with bigger land holding size are assumed to have the ability to purchase improved technologies and the capacity to bear risk if technology fails (Feder e*t al.*, 1985). This was confirmed in the case of fertilizer by Nkonya *et al.* (1997) in Tanzania, Hassan *et al.* (1998a) in Kenya and Yohannes *et al. (1990)* in Ethiopia whereas; farm size did not matter in Nepal (Shakya and Flinn, 1985).

The role of education in technology adoption has been extensively discussed in the literature. Education enhances awareness of more sources of information, and is more efficient in evaluating and interpreting information about innovations than those with less education (Wozniak 1984). Education was found to positively affect adoption of improved maize varieties in West shoa, Ethiopia (Alene *et al.,* 2000), Tanzania (Nkonya *et al.,* 1997) and Nepal (Shakya and Flinn, 1985).

Some new technologies are relatively labour saving and others are labour using. For those labour-using technologies like improved varieties of seeds and fertilizer, labour availability plays significant role in adoption. Green and Ngongola (1993) found regular labour to be an important factor that positively influences adoption of fertilizers in Malawi.

On the other hand, age of the household head is an important factor affecting adoption of agricultural technologies. The conventional approach to adoption study considers age to be negatively related to adoption based on the assumption that with age farmers become more conservative and less acceptable of new ideas. On the other hand, it is also argued that with age farmers gain more experience and acquaintance with new technologies more efficiently. Some studies found age to be an important determinant of adoption (Hassan *et al,* 1998b), while others didn't (Voh, 1982, Nkonya *et al.,* 1997*;* Chilot *et al.,* 1998).

The effect of family size on adoption can be ambiguous. It can hinder the adoption of technologies in areas where farmers are very poor and the financial resources are used for other family commitments with little left for purchase of farm inputs (Voh, 1982; Shakya and Flinn, 1985). On the other hand, it can be an incentive for adoption of new technologies as more agricultural output is required to meet the family food consumption needs (Yonannes *et al.*, 1989) or as more family labour is required for adoption of labour intensive technologies (Hassan *et al.*, 1998a).

In addition, adoption of new agricultural technologies depends on a number of institutional factors. The introduction of new technologies creates demand for information useful in making decisions (Wozniak, 1984). Agricultural extension organizations supply useful information about new agricultural technologies. Access to such sources of information can be crucial in adoption of improved varieties (Nkonya *et al.,* 1997; Hassan *et al.*, 1998b; Chilot *et al.,* 1998). Furthermore, risk associate with the adoption of agricultural technologies is another important factor in adoptions (Parikh and Bernard, 1988; Yohannes *et al.*, 1990; Shiyani *et al.*, 2002; Hassan *et al.*, 1998).

The studies reviewed above show inconsistent results about the determinants of adoption of new technologies by farmers. In addition, none of the above studies address how adoption of fertilizer is affected by farmers' perception about the expected rainfall conditions, the perception of farmers about the current prices of fertilizers, technologies and the topographic conditions of rice farm plots.

4. The Specification of Empirical Model

In light of the results of previous empirical research, this study considered a number of explanatory variables in modeling the fertilizer adoption behavior of rice farmers in Bangladesh. Socio-economic factors such as age of the household head, family size, literacy, farm size, extension service, access to credit, distance of market, farm income and non-farm income of the farmers were considered important determinants of adoption. The age of the household head (Age) is measured by years, farm size (farm size) is measured in hectare and literacy (Education) takes a value of 0 if the farmer is illiterate and 1-17 on the basis of school going years. Household size (Household size) is measured by the number of people living in the household. Income from farm sources (Farm Income) and off farm sources (Non-farm Income) are included to reflect the financial ability of the farmer to buy external inputs, both were measured by the amount of income earned from the respective activities. The topographical nature of land (Land Type), which takes the value of one if the plot is low and zero otherwise is included. Furthermore, to see the effect of credit associated with the use of fertilizer, farmers' perception about the credit facility (Access to Credit) during the production year was included. This is measured as one if the farmer receives credit and zero otherwise. Distance of the home of the farmer (Distance from the Market) from the nearby market where fertilizer is available is measured in kilometer is selected to capture the impact of institutional constraints on fertilizer adoption in the area. Agriculture Extension Service program for the farmers is included in the model since it has an important impact on fertilizer application. This is measured by value one if farmers get the service and zero otherwise.

The above explanatory variables were used to estimate the Probit and Tobit models of fertilizer adoption as specified below.

$$\begin{aligned} AF = \beta_0 \; + \; & \beta_1 Age + \beta_2 Land\ type + \beta_3 Literacy + \beta_4 irrigation\ facility \\ & + \beta_5 Farmincome + \beta_6 Nonfarmincome + \beta_7 Household\ size \\ & + \beta_8 Distance\ of\ Market \; + \beta_9 Extention\ service + \beta_{10} Type\ of Seed \\ & + \beta_{11}\ Credit \end{aligned} \tag{4}$$

Where AF (Adoption of Fertilizer) takes the value of one if farmers use fertilizer more than the minimum required level (minimum required level 351.97 kg per hectare, BRRI, 2010) and zero for using fertilizer below the minimum level in the case of the Probit model and is the level of fertilizer used in kg per hectare of land in the Tobit model.

5. Study Area and Sampling Procedure

The study is conducted in Rajshahi District, located in the Northwest part of Bangladesh. Being part of Barind highlands, the area receives an average annual rainfall of more than 813 mm. Rice, wheat, pulses and maize are the cereals grown in the area. Rice is the staple crop in this district. Being one of the major rice producing districts in the Northwest region, the area has been included in the Barind Multipurpose Development Project since 1985. Firstly, for collecting primary data, a multistage random sampling technique is used for the study. One thana named Poba is randomly selected from nine thanas in Rajshahi district in the first stage. In the second stage, three villages are randomly selected from Poba thana. Source from the district level office of agriculture shows that about 100% of the farmers in the study area use fertilizer in rice production. After listing farmers in each village, 30 respondents are randomly selected using simple random sampling from each village. One purposive sample of a total of 90 farm households is surveyed. The primary data are collected with the aid of a well structured questionnaire, including such variables as quantity of fertilizers applied, age of farmers, year of schooling of farmers, farm size, land type, irrigation facility access to credit, farm income and non-farm income etc.

6. Results and Discussion

The explanatory variables of the Probit model reported in Table 1 had the expected sign. Age is positively but insignificantly related to the adoption of fertilizer suggesting that age of the farmer doesn't bear any significant meaning.

Farmers' expectation of a good rainfall season and ease of access to irrigation facility are positively and significantly associated with fertilizer adoption. Farmers' perception about credit facility is negatively and significantly connected with fertilizer use of the farmers in the study area. High interest rate and difficult official procedure discourage farmers to take credit from banking and non-banking sources for the purpose of fertilizer use. Non-farm incomes of the farmers negatively but significantly affect the farmers' decision of fertilizer adoption.

The factors influencing fertilizer use intensity among the farmers in the study area are shown in Table 2. Irrigation facility and access to credit are significant factors at 5% level of probability in the use of fertilizer in the study area. These imply that farmers with ease of access to irrigation and credit facilities use more fertilizer than those with limited access to irrigation and credit facility.

Table 1 : Estimated Results of Probit Model of Adoption of Fertilizer

Variable	Coefficient	Standard error	z	P-value
Age	0.020875	0.0141509	1.48	0.140
Education	-0.016944	0.0378936	-0.45	0.655
Land Type	-0.236486	0.5090107	-0.46	0.642
Distance from Market	-0.160171	0.1854242	-0.86	0.388
Irrigation Facility	1.543736**	0.6396538	2.41	0.016
Access to Credit	-0.628958*	0.3409387	-1.84	0.065
Extension Service	0.408659	0.3741495	1.09	0.275
Farm Income	1.983060	2.5701206	0.77	0.441
Non Farm Income	-3.812060*	2.3110016	-1.65	0.099
Constant	-1.229850	1.0750412	-1.14	0.253

Authors Own Calculation; Restricted Log likelihood -39.314; Chi-Square 0.0364; *** Significant at 1% ; ** Significant at 5% and * Significant at 10%

Type of land is significant and has a positive sign. This indicates that the adoption and intensity of the use of fertilizer in low land is higher than upland. The extension service in the study area has a significant but negative relationship to the decision of the use of chemical fertilizer. It is significant at 10% level and implies that by increasing the frequency of extension service in one unit reduces the excess fertilizer use by 71.36 kg per hectare.

Table 2 : The Tobit Model of Fertilizer Adoption in Rajshahi District

Variable	Coefficient	Standard error	z	P-value
Age	0.0328621	0.9717153	0.03	0.973
Education	1.117135	2.609355	0.43	0.669
Land Type	56.12218*	34.00643	1.65	0.099
Distance from Market	4.764358	12.74537	0.37	0.709
Irrigation Facility	78.91047**	38.15438	2.07	0.039
Access to Credit	90.38503**	39.22689	2.30	0.021
Extension Service	-71.35883*	40.29018	-1.77	0.077
Farm Income	-0.0002317	0.0001663	-1.39	0.163
Non Farm Income	-0.0000565	0.0001293	-0.44	0.662
Constant	307.6936	68.49777	4.49	0.000

Authors Own Calculation; Restricted Log likelihood -420.77823; Chi-Square 12.69; *** Significant at 1% ** Significant at 5% and * Significant at 10%

7. Conclusions and Policy Implications

Chemical Fertilizer is considered the most important input for the achievement of increased agricultural productivity and food security status of farm households in Bangladesh. However, fertilizer adoption remains very low, especially among small-scale and marginal farmers in the country. The results of this study show that the irrigation facility, access to credit, land type, non-farm income significantly affect the use and intensity of adoption of fertilizer in the study area.

In situations where the expected rainfall condition is bad or irrigation facility is limited, farmers are unwilling to use fertilizer. This is because farmers are not insured against losses as a result of draught weather or shortage of irrigation facility and forced to pay the cost of fertilizer they received on credit. Agricultural research has to focus on the development of moisture stress tolerant and early maturing varieties. In addition, the expansion of small-scale irrigation projects like Barind Multipurpose Development Project in rural areas can help overcome the adverse effects of rainfall shortage or limited facilities of irrigation experienced by most parts of the country.

The government and its agricultural extension office should impart knowledge and skills in farmers through avenues such as training, extension agent contact with farmers or any other means of capacity building. Collateral free loan facility with low interest rate and exemption from liabilities of loan in bad harvesting season will encourage farmers to use more fertilizers. Government should also establish institutions and encourage formation of cooperatives that offer micro-finance and loans to farmers in order to mobilize savings and maximize the availability of credit to the farmers. The development of rural roads reduces the transaction cost associated with acquisition of farm inputs and sale of farm products. This enables farmers to buy farm inputs at lower prices and sell their produce at competitive prices. More effort in expanding roads in rural areas is therefore needed.

References

1. Basak, J.K. (2010). Fertilizer Requirement for Boro Rice Production in Bangladesh. Unnayan Onneshan – The Innovators.
2. Ellis, F. (1997). Hoesehold Strategies and Rural Livelihood Diversification. Paper presented at Annual Conference of Development Studies Association, University of East Anglia,England, 11-13 September 1997.
3. Hassan, R.M. and Fufa, B. (2006). Determinants of Fertilizer Use on Maize in Eastern Ethiopia: A Weighted Endogenous Sampling Analysis of the Extent and Intensity of Adoption. Agrekon, Vol 45, No 1, 38-49, March 2006.
4. BRRI (2010). Bangladesh Rice Research Institute, Ministry of Agriculture, Government of the People's Republic of Bangladesh.
5. Nkamleu, G. B. and Adesina, A. A. (1999). Determinants of Chemical Inputs use in Peri-urban Lowland Systems: Bivariate Probit Analysis in Cameroon. Agricultural Systems 63 (2000) 111-121.
6. Rogers, E. M. (1995). The diffusion of Innovations (4^{th} ed.). New York, Free Press.
7. Scherr, S. J. (1995). Economic Factors in Farmer Adoption of Agroforestry: Patterns Observed in western Kenya. World Development, 23, 787-804. Http://dx.doi.org/10.1016/0305-750X (95)00005-W
8. Tobin. J. (1958). Estimation of Relationships for Limited Dependent Variables. The Econometrica 26:24-36.

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 223-233
Bangladesh Economic Association
(ISSN 2227-3182)

Economics of Cereal Crops in North-western Part of Bangladesh

Mohammad Monirul Islam*
Md. Elias Hossain**

Abstract *The present study is an effort to analyze the profitability of selected cereal crops in the north-western part of Bangladesh using farm level survey data. Required data were collected from four villages of north-western part of Bangladesh. A simple multistage random sampling technique was used to collect data. Cost-benefit analysis approach is also used, which enabled us to assess the profitability of cereal crops. The major findings of the study showed that growing cereal crops was profitable as net returns for paddy (Tk. 2047), wheat (Tk. 3236) and maize (Tk. 4550) per bigha were found as positive. This is supported by the benefit-cost ratios (BCR) with the value of 1.57 for paddy, 1.74 for wheat and 1.86 for maize. Both BCR and financial analysis suggest that producing maize is more profitable compared to paddy and wheat. A multiple regression analysis was also done to explore the contribution of inputs to gross return. The study found positive contribution of irrigation and seed cost to gross return from paddy, wheat and maize in the study area. On the other hand, pesticide cost has negative contribution to gross return from paddy and land preparation cost and fertilizer cost have also negative contribution to gross return from wheat. Surprisingly, all the inputs cost have positive contribution to gross return from maize. The study also found decreasing returns to scale in the case of producing cereal crops. Equi-marginal principle was used to check the efficient use of resources, which found inefficient use of resources for the production of paddy, wheat and maize.*

* PhD Fellow, Institute of Bangladesh Studies (IBS), Rajshahi University, Rajshahi-6205
** Professor, Department of Economics, Rajshahi University, Rajshahi-6205

1. Introduction

Bangladesh is an agriculture dependent country. The major source of livelihood of the people of Bangladesh is agriculture. It employs nearly 47.5% of labour force and contributes about one sixth of gross national product of the country. Paddy, wheat and maize are the principal cereal crops whereas *barly,* millet, *bazra, cheena* and *kaon* are minor cereal crops in Bangladesh. More than 80% cultivable land is devoted to produce cereals in the country. Among three main cereal crops rice production dominates the farming system of Bangladesh, accounting for 75% of gross cropped area whereas only 2.5%, and 1.11% land is devoted to produce wheat and maize respectively (BBS, 2011). Rice sector provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country (Bhuiyan et al, 2002). Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Although Bangladesh is a cereal crop producing country, Government of Bangladesh has to import food crops almost every year. For example, the total food grain import in 2010-11 was about 5.31 million metric tons (mt) of which 1.56 million mt. was rice and 3.75 million mt. wheat (MoFDM, 2012). With the initiation of the *Green Revolution* in the early 1970s farmers became familiar with modern HYV seeds, irrigation and fertilizer technology that augmented production of major cereals enormously at the cost of various minor crops. Rahman (2010) observed that intensive rice monoculture led to displacement of land under low productive non- rice crops. But the problem is that, although *Green Revolution* had increased yield, farmers were not aware of the proper usage of that technology. As a result rice monoculture, usage of irrigation, chemical fertilizer, pesticide etc. has been increased over the years. Ultimately, it increases production cost and reduced farmers' profit margin. In addition, shrinking of agricultural land due to ever increasing demand for housing, industrialization and infrastructure development became a notable problem in agriculture. Gradually it is found in many instances that farmers are moving to maize production or other cash crop production because of lesser profit margins associated with rice farming. For example, Siddique (2013) found farmers are losing interest in cultivating *boro* due to high production cost and low market price and they are being forced to grow crops like maize.

North-western part of Bangladesh is popularly known as the granary of Bangladesh. Due to various facilities like irrigation intensity, cheap labor force, farmers' efficiency and devotion to agriculture the area grows a verity of crops. This region is still a food surplus region in Bangladesh. Cropping intensity in this region is very high compared to other areas of the county. Like other regions of the country, north-western part has also been facing a problem of transformation of crop land into fish farming and fruits farming due to expectation of high profit margin. Thus, the decision to produce rice by farmers is getting vulnerable day by day which poses a threat to food security in Bangladesh. In many discussions it is found as quoting by the farmers that they do not want to produce paddy any more if they have opportunity to cultivate other crops. However, reports reveal that still more than 75% land in the country is devoted to rice farming. Therefore, it is required to make a comparative study of different cereal crops with the perspective of economic viability to the farmers.

The present study is an attempt to analyze the profitability of cereal crops in North- Western Bangladesh. Specifically this study concentrates on i) measuring cost and benefit involved with cereal crop production ii) determining the contribution of inputs to gross return, and iii) analyzing the economic efficiency of resource use in cereal farming.

2. Literature Review

A good number of studies have been carried out on measuring the costs and benefits of various cereal crops, like paddy, wheat, maize etc. Majumder et al (2009) studied the efficiency and productivity of *boro* rice production by owners, cash tenants and share cropper tenants. They found that efficiency and productivity of the owner and cash tenant farmers are higher than share cropper tenants. Moniruzzaman et al (2009) studied benefit cost ratio of maize production. They calculated benefit cost ratios on the basis of total cost, variable cost and cash cost for the cereal crops- rice and maize. The result found is that, maize cultivation was more profitable than rice cultivation.

Jahangir Kabir and Islam (2012) did a comparative study between wheat and rice production and found that net return from wheat is higher than that of *aman* and *boro* rice. Rahman et al (2012) studied technical efficiency of rice producers using stochastic frontier model. They found that gross return was the highest for small farms and net return was the highest for marginal farms. The lowest net return or the highest cost of production was mounted up from both the highest wage rate and highest amount of labor used in medium farms. The marginal farms experienced the highest benefit-cost ratio (BCR) followed by small and medium farms. Ali et al (2009) studied maize- rice cropping system in Bangladesh and they found hybrid maize far more profitable than *boro* (irrigated) rice, wheat, or most other competing winter season *Rabi* crops.

3. Methodology

3.1 Sample Selection

The study was conducted in four villages of North Western region of Bangladesh. These villages are chosen from two districts- Rajshahi and Thakurgaon, belonging to two divisions which constitute north-western Bangladesh. The two villages are Gholharia and Mollikpur under Paba upzila of Rajshahi district and the other two villages are Chapor and Hatpara under Pirgonj upzila of Thakurgaon district. In doing the sampling, at the first stage, two districts were chosen from two divisions of north-western Bangladesh. In the next stages, two upazilas from two districts, two unions from the two selected upazilas and two villages from each of the two unions were selected. Finally households were selected randomly from the villages. A total of 173 farmer households (taking at least 40 from each village) were selected and interviewed using structured questionnaire.

3.2 Empirical Model

3.2.1 Techniques of Cost-Benefit Analysis

The gross return of producing cereal crops was derived from the sale revenue of crops.

Thus, $GR = Q \times P$……………………………..…............................(1)

Where, GR = Gross return
Q = Total production and
P = Per unit price of cereal crop

Again we know that gross margin is equal to gross return less total variable cost and net return is equal to gross return less total cost. Thus,

$GM = GR - TVC$……………………………..….............................…(2)

Where, GM = Gross margin
TVC = Total variable cost

$NR = GR - TC$……………………………….…..............................…..(3)

Where, NR = Net return
TC = Total cost (sum of variable cost and fixed cost)

In addition to financial or activity budget analysis, benefit cost ratio (BCR), calculated by using total variable cost (TVC) and total cost (TC), was also used to assess the profitability of producing cereal crops.

3.2.2 Cobb-Douglas Production Function

Cobb-Douglas form of production function was used to estimate the major factors affecting gross return for paddy, wheat and maize production. It is the most widely used model for fitting agricultural production data, because of its mathematical properties, ease of interpretation and computational simplicity (Heady & Dillon, 1961). It is a homogeneous function that provides a scale factor enabling one to measure the returns to scale and to interpret the elasticity coefficients with relative ease. Cobb-Douglas production function is also relatively easy to estimate because in logarithmic form it is linear and parsimonious (Beattie & Taylor, 1985). Thus, Cobb-Douglas specification provides an adequate representation of the agricultural production technology. The empirical Cobb-Douglas frontier production function model can be expressed as,

$$Y = AX_1^{b_1} X_2^{b_2} \ldots X_n^{bn} e^{ui} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

The production function is transformed into logarithmic (double log) form, that is, log linear form so that Ordinary Least Squares (OLS) estimation method can be used to estimate the model. The log linear form of the model is;

$$logY = log\,A + b_1 logX_1 + b_2\, logX_2 + \ldots\ldots + b_n\, logX_n + u_i \ldots\ldots\ldots\ldots(5)$$

In different studies various factors and factor costs were found to have significant contribution to gross return from cereal crops cultivation. These are land preparation cost, labor cost, seed cost, fertilizer costs, pesticide costs, irrigation cost etc. Thus, the specification of the above Cobb- Douglas function in logarithmic form is as follows:

$$logY = logA + b_1 log\,X_1 + b_2 log\,X_2 + b_3\, logX_3 + b_4 log\,X_4 + b_5 log\,X_5 + b_6 log\,X_6 + u_i \ldots\ldots(6)$$

Where, Y = Gross return from Paddy/ Wheat/ Maize (BDT/ bigha)

X_1 = Land preparation cost (BDT/ bigha)
X_2 = Labor cost (BDT/ bigha)
X_3 = Seed cost (BDT/ bigha)
X_4 = Fertilizer cost (BDT/ bigha)
X_5 = Pesticide cost (BDT/ bigha)
X_6 = Irrigation cost (BDT/ bigha)

b_1, b_2, b_3, b_4, b_5 and b_6 are regression coefficients and u_i is the stochastic disturbance term which is independently and identically distributed random errors with zero mean and constant variance, that is, .

3.3.3 Equi-Marginal Principle

The resource use efficiency of the farmers was tested by applying equi-marginal principle of neo-classical theory (Majumder et al, 2009). Neo-classical theory states that in order to ensure maximum profit and efficient use of resources, it must be utilized at the level where their marginal value product (MVP) is equal to their marginal factor cost (MFC) under perfect competition. It is calculated by using the basic economics formula as MVP/ MFC= 1. That is, efficiency of the inputs was measured by the ratio of marginal value product (MVP) to the marginal factor cost (MFC) of each variable input. When MVPs are equal to MFCs then the profit is maximized. If it is greater than one, the resource is under used and if it is less than one, the resource is over used. As the MFC is the price of input per unit, the MFCs of all the inputs will vary while calculating the ratio of MVP to MFC. However, the denominator will always be one, and therefore, the ratio will be equal to their respective MVP (Majumder et al, 2009). MVP is calculated by the following formula;

$$MVPx_i = bi * \overline{Y}_{GM} / \overline{X}_{iGM} \quad \ldots\ldots\ldots\ldots(7)$$

Where, b_i is the regression coefficient, Geometric Mean of Gross Return, Geometric Mean of variable inputs.

To estimate the regression, SPSS version 17.0 was used. Multicollinearity was checked using Variance Inflation factor (VIF), the calculated values were less than 5 (the cutoff point) for all the predictor which indicates that Multicollinearity was not a serious problem in the model. Durbin Watson test was also carried out for checking auto correlation. Independent sample *t* test was carried on to find out the difference between the mean value of the selected socio- economic and demographic characters of the farm and farmers' of the study areas.

4. Result and Discussion

4.1 Socio-economic and Farm Level Characteristics of the Farmers

The socio-economic and farm level characteristics are presented in Table 1. From the table it is found that average age of the sample farmers is 42.38 years in the study area which is statistically significant considering regional mean difference in the age of the farmers of Rajshahi and Thakurgaon districts. Average age of the farmers of Rajshahi is smaller than that of Thakurgaon. Similar picture is seen in the case of average land ownership, farm size and annual family income. Another notable characteristic of the farm in north-western part of Bangladesh is irrigation intensity. 84.73% cultivable land has under irrigation facility which is much higher than that of the national average. The reason behind higher land under irrigation might be the irrigation facility of Barind Multipurpose Development Authority (BMDA). In recent years BMDA has installed more than thousand deep tube-wells in north-western region. In addition, quite a large number of shallow tube-wells have been installed by private initiatives for irrigation purpose. Average education level and family size of the farmers are found as 5.05 years of schooling and 5.28 persons, respectively, and there is no significant difference between the considered districts.

4.2 Results of Profitability Analysis of Cereal Crops (bigha)

Table 2 shows the results of cost-benefit analysis of three main cereal crops in north-western part of Bangladesh. Table 2 reveals that gross margin and net margin for paddy, wheat and maize is positive which indicates that producing these three cereal crops are profitable in the study area. The benefit-cost ratios (BCR) of paddy, wheat and maize are also greater than unity which also indicates that producing major cereal crops are profitable. From Table 2 it is clear that gross margin, net margin and BCR are higher for maize production than wheat and paddy. The reason might be the high demand for maize for feeding fish and poultry which ensure high price of maize and another reason might be the high rate of yield of maize.

Table 1 : Socio-economic Characteristics of the Farmers

Socio economic character	Rajshahi	Thakurgaon	All	t-value
Age of the respondent	39.93	45.06	42.38	-3.20***
Education of the respondent	5.05	5.04	5.05	0.04
Experience of the respondent	23.92	23.10	23.53	0.51
Family size	5.42	5.13	5.28	0.98
Land ownership	183.19	268.19	223.74	2.09**
Farm size	206.26	340.29	269.88	-3.21***
Annual family income	173204	227560	199132	-4.51***
Irrigation coverage	85.27%	84.13%	84.73%	0.97

Source: *Authors' Own Calculation.*

Note: *** Significant at 1% level, ** Significant at 5 % level, * Significant at 10 % level

4.3 Discussion of Regression Results

The regression results are shown in Table 3. The estimation results reveal that pesticide cost is statistically significant and negatively related to gross return of paddy indicating that 1% increase in pesticide cost would decrease gross return of paddy by 0.12%. Irrigation cost is statistically significant and has positive relation to gross return of paddy. This result means that 1% increases in irrigation cost would increase gross return from paddy by 0.09%. The other inputs cost like land preparation cost, labor cost, seed cost, fertilizer cost also have positive effect on gross return form paddy but they are statistically insignificant.

Table 2 : Results of Profitability Analysis of Cereal Crops (bigha)

Particular	Paddy	Wheat	Maize
A. Yield (Mound)	19.31	14.31	26.67
B. Gross Return (Tk.)	13050	13240	14714
C. Total Variable Cost (Tk.)	8321	7596	7898
D. Fixed cost (Tk.)	2682	2408	2266
E. Total Cost (Tk.)	11003	10004	10164
F. Gross Margin (B-C)	4729	5644	6816
G. Net Margin (B-E)	2047	3236	4550
H. BCR Over TVC (B/C)	1.57	1.74	1.86
I. BCR Over TC (B/E)	1.19	1.32	1.45

Source: *field survey, 2013*
Note: ***Significant at 1% level, ** Significant at 5 % level, * Significant at 10 % level

Land preparation cost has negative influence on gross return of wheat. This result indicates that 1% increase in land preparation cost will decrease gross return by 0.19 %. Again from the result it is observed that 1% increase in labor cost and seed cost will increase gross return from wheat by 0.15% and 0.18%, respectively. Fertilizer cost has negative and irrigation cost has positive change on the gross return from wheat. From the estimated result it also appears that the gross return from maize is positively influenced by pesticide cost and it is highly significant. Other input cost like land preparation cost, labor cost seed and seedling cost, fertilizer cost and irrigation cost also influence the gross return from maize positively but these are not statistically significant.

4.4 Results of Resources Use Efficiency

Table 4 presents the results of resources use efficiency in paddy, wheat and maize production. Power tiller/tractor, labor, seed, fertilizer, pesticide and irrigation are the main resources of paddy, wheat and maize production. We tested all the inputs' efficiency by Marshalian equi-marginal principle by the ratio of MVCs and MFCs of the inputs.

Table 3 : Regression Results

Explanatory variables	Paddy		Wheat		Maize	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Intercept	3.75***	6.68	3.63***	6.66	2.73***	3.87
Land preparation cost (X_1)	0.04	.59	-.19**	-2.00	.05	.99
Labor cost (X_2)	0.03	.05	.15*	1.68	.01	.03
Seed/seedling cost (X_3)	0.05	.51	.18*	1.91	.03	.36
Fertilizer cost (X_4)	0.05	.68	-.04	-.75	.01	.20
Pesticide cost (X_5)	-0.12**	-1.95	-	-	.21***	2.77
Irrigation cost (X_6)	0.09***	3.21	0.07	1.01	.19	1.56
R^2	.21		0.11		0.17	
Adjusted R^2	.18		0.06		0.1	
F- Value	7.29***		2.3**		2.29**	
DW	1.56		1.46		1.39	
Returns to scale (? b)	0.14		.17		.50	

Source: *field survey, 2013*
Note : *** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level

It is evident from Table 4 that in the case of paddy production, the ratio of MVP and MFC of seed and irrigation cost is greater than one, which indicates that farmers have more scope to use these resources to increase return from paddy. On the other hand, since the ratio of MVP and MFC of land preparation cost, labor cost and fertilizer cost is less than one, farmers should limit the use of these resources to increase return from paddy production. In case of pesticide, the ratio of MVP and MFC is negative, which indicates that farmers use pesticide excessively. If we look at wheat production, it is clear that the ratio of MVP and MFC of seed and irrigation cost is greater than unity. It indicates that farmers have more scope for the use of resources to increase return. Labor use should be limited to increase return from wheat production. In addition, the ratio of MVP and MFC of land preparation and fertilizer cost indicates that farmers use the resources excessively. Now, if we turn to the gross return of maize, we see that there is more scope to use fertilizer and irrigation in maize production to increase gross return, whereas the ratio of MVP and MFC of land preparation cost and seed cost indicates that usage of this resources should be limited to increase gross return. Labor and pesticide have been used excessively in maize production.

Table 4 : Resources Use Efficiency of the Inputs

Inputs	Paddy		Wheat		Maize	
	GM	$MVPx_i/MFCx_i$	GM	$MVPx_i/MFCx_i$	GM	$MVPx_i/MFCx_i$
Gross Return	12973	-	13156		14678	-
Land preparation cost (X_1)	1017	0.51	1041	-2.40	844	0.70
Labor cost (X_2)	3365	0.12	2901	0.68	3502	-0.13
Seed/seedling cost (X_3)	567	1.14	782	3.03	561	0.26
Fertilizer cost (X_4)	1849	0.35	2071	-0.25	1788	1.23
Pesticide cost (X_5)	508	-3.06	-		432	-0.68
Irrigation cost (X_6)	864	1.35	699	1.32	659	2.23

Source: *Authors' Own Calculation*

5. Conclusion

Cereals are the prime sources of carbohydrate. In Bangladesh cereals especially rice is the staple food for human beings. Wheat and maize are also used as food crops in Bangladesh. It is found from the study that maize and wheat are now more profitable cereal crops than paddy. Farmers are becoming reluctant to grow rice which is a great threat for food security. To ensure food security at all levels government should come forward to ensure fair price for cereal crops and take necessary steps to change the food habit of the people of Bangladesh.

Reference

1. Ali, M. Y., Waddington, S. R., Timsina, J., Hodson, D. & Dixon, J. (2009). "Maize-rice cropping systems in Bangladesh: Status and research needs". *Journal of Agricultural Science and Technology, 3*(6/19), 35-56.

2. Awal, M. A. & Siddique, M.A.B. (2011) "Forecasting of rice production in Bangladesh employing by ARIMA model". *Bangladesh J. Agril. Res. 36*(1), 51-62.

3. BBS, (2011). 2011 Y*earbook of agricultural statistics of Bangladesh*. Dhaka: Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh.

4. Beattie, B. R. & Taylor, C. R. (1985*). The Economics of Production*. John Wiley and Sons: New York.

5. Bhuiyan, N. I., Paul, D. N. R. & Jabber, M. A. (2002). "Feeding the extra millions by 2025– Challenges for rice research and extension in Bangladesh". *National Workshop on Rice Research and Extension in Bangladesh,* Bangladesh Rice Research Institute, Gazipur, 29-3 1.

6. Coelli, T., Rahman, S. & Thirtle, C. (2002). "Technical, allocative, cost and scale efficiencies in Bangladesh rice cultivation: a non-parametric approach". *J Agril Econ 53*(3), 607-626.

7. GoB, (2013). *Bangladesh economic review*. Economic Adviser's Wing, Finance Division ministry of Finance, Government of the People's Republic of Bangladesh.

8. Heady, E. O. & Dillon, J. L. (1961). *Agricultural Production Functions*. Iowa: Iowa State University Press, Ames.

9. Majumder, M. K, Mozumdar, L. & Roy P. C. (2009). "Productivity and resource-use efficiency of Boro rice production". *Journal of Bangladesh agricultural University*, *7*(2), 247-252.

10. Ministry of Food and Disaster Management (MoFDM). (2012). "Monitoring Report of the National Food Policy Plan of Action and Country Investment Plan". FPMU, Food Division, MoFDM, Khadday Bhaban, Dhaka.

11. Moniruzzaman, M., Rahman, S., Karim, M. K. & Alam, Q. M. (2009). "Agro-economic analysis of maize production in Bangladesh: a farm level study". *Bangladesh J. Agril. Res. 34*(1), 15-24.

12. Rahman, A. (2010). *Promoting financial inclusion for poverty reduction with inclusive growth.* Bazlur Rahman Memorial Lecture. Dhaka. Bangladesh.

13. Rahman, K. M. M., Mia, M. I. A. & Bhuiyan, M. K. J., (2012). "A Stochastic Frontier Approach to Model Technical Efficiency of Rice Farmers in Bangladesh: An Empirical Analysis". *The Agriculturists 10*(2), 9-19.

14. Siddique, A. B. "Farmers losing interest in boro". Dhaka Tribune. 30th July, 2013.

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 235-251
Bangladesh Economic Association
(ISSN 2227-3182)

Factors Influencing the Intensity of Market Participation by Rice Farmers in Gopalganj District: An Empirical Analysis

ZUBAIDUR RAHMAN*
MD. ELIAS HOSSAIN**

Abstract *This paper investigates the factors affecting market participation by rice farmers in Gopalganj district using Tobit model. Data were collected through well structured questionnaire from 100 farmers through random sampling technique. The farmers in the study area recognized 'weak insfrastucture' as the major constraint to market participation. About 95 out of the 100 sample farmers were market participants operating at various levels of market participation as revealed by the total market participation index (TMPI); 11 farmers, 17 farmers, 32 farmers and 35 farmers participated in the market at levels 1, 2, 3 and 4, respectively. The Tobit regression result showed that age, education, size of output, training, cooperative membership and price per kg. rice have positive and significant impact on the ability of farmers to participate in market while the same is influenced negatively by gender, family size, non-farm income, agriculture extension visits, market information, and distance.*

Keywords: *Market participation, Rice farmers, TMPI, Tobit.*

1. Introduction

Market participation is considered to have a vital impact for the farmers to increase their income, which in turn enhances their standard of living. Market increases purchasing power of farmers by raising their incomes, which again create demand for non-agricultural goods that helps to expand market. An

* Lecturer, Department of Economics, Bangabandhu Sheikh Mujibur Rahman Science and Technology University, Gopalganj-8100
** Professor, Department of Economics, Rajshahi University, Rajshahi-6205

increase in the level of income of the farmers' motivate to accumulate savings, which are turned into investment, and at the same time provide the opportunity for improved nutrition and balanced diets and, therefore, help alleviate poverty. Market participation is both a cause and a consequence of economic development. Markets offer households the opportunity to specialize according to comparative advantage and thereby enjoy welfare gains from trade.

Market participation refers to how much amount of total output is brought for sale in the market at current market price within a specific period of time particularly one year. Any market related activity which promotes the sale of produce is known as market participation (Key *et al*., 2000; Holloway and Ehui, 2002; Lapar *et al*., 2003). Market participation can be referred as commercialization (Latt and Nieuwoudt., 1998). The research study conducted by Staal *et al* (1997) argued that a low portion of products exchanged in the market reflects limited market participation. Goetz (1992) consider households purchase and sales to define market participation. Volumes of produce traded are used to determine market participation. In an agricultural based economy, market participation or commercialization occurs mainly when farmers shift their production decision from subsistence to commercialization and then farmers become profit oriented. Market participation in that case can be defined as earnings from market activities (Makhura *et at*., 1997).

Rice occupies 11 percent of world agricultural land. World market of rice is dominated by Asia as it accounts for about 90 percent of world's rice area and 92 percent of production. Asia being the most populated region of the world, the major proportion of rice produced is consumed within the continent (FAO, 2004). Rice is the most important food crop in Asia as it contributes 60% of households' calorie consumption, and about 90% of the world's rice output is produced and consumed in the continent (FAOSTAT 2012). In Bangladesh, agriculture sector is dominated by crop sub-sector and crop sub-sector is dominated by rice (paddy) production. Rice supplies 71% of the total calories and 51% of the Protein in a Bangladeshi diet (BBS, 1998). In spite of this, rice yield in Bangladesh is 4.4 t ha^{-1}, which is lower than that of countries (China-6.6 t ha^{-1}, Philippines 6.01 ha^{-1}, Vietnam 4.63 t ha^{-1}), and higher than the world average (4.2 t ha^{-1}) (FAOSTAT 2012). In addition, there is high disparity between potential and national average rice yield in this country. One of the reasons for this is poor access to farmers in market.

Though rice is the major consumed item for the people of Bangladesh, its production is kept beyond their optimum level due to several constraints relating to market participation. Excluding subsistence farming, the prime objectives of all other farming is to make profit by selling their output in market. But farmers often fail to get the fair price of their product due to several barriers relating to market participation viz. weak transportation facilities, weak infrastructure, influence of middleman on price, inequitable market price, lack of market information etc. As a result, farmers are seen to shift their production decision from rice to other crops. Improving the condition of market will provide incentives to farmers that help to increase productivity as well as production of rice, without which the continuous increase in demand for rice may not be met. For the establishment of efficient and well functioning markets, intensification of production system should be ensured that helps to keep transaction costs low, minimize risk and extend information to all participants, particularly those living in areas of marginal productivity and weak infrastructure (IFAD, 2003;World Bank, 2008). Many policy makers and development economists have emphasized the significance of market participation in agricultural and economic development. Market participation contributes to overall development and is the determinant of agricultural growth (Gani & Adeoti, 2011; Borbala et al. 1998). To this end, increased integration of farmers into markets at local, regional and national levels becomes an issue of paramount significance.

2. Literature Review

Several studies were done in this field both in domestic and abroad (Omiti *et al.* 2009; Lapar et al. 2003; Mauti *et al*., 2013; Daramola and Oparinde, 2014; Benin *et al.* 2003). Most of the studies focus on the determinants of market participation by using different approach. The findings of these studies widely differed from each other in terms of existing relation between market participation and its determinants. Omiti *et al.* (2009) conducted a research on the intensity of market participation among smallholder farmers in Kenya. The empirical results suggest that farmers in peri-urban areas sold higher proportions of their output than those in rural areas and distance from farm to point of sale is a major constraint to the intensity of market participation. The research study conducted by Lapar *et al.,* (2003) aimed to seek policy options that promoting market participation among smallholder livestock producers in Philippines' using Probit and Tobit ideas and they concluded that weak infrastructure is the major barrier towards market participation. Adeoti *et al.* (2008) aimed to investigate the determinants of market participation among maize producers in oyo state, Nigeria using censored Tobit model. They concluded that market price, member of a producer group, farm size, educational status and total maize produced, road condition, primary occupation and transaction costs significantly affect farmers' market participation.

Mauti *et al.,* (2013) conducted a research where they investigate the factors that determine farmers' shift in market participation from village to regional market in Vihiga County. Results of the study indicate that participation in local town market rather than village market was influenced by credit access, total income, transport mode to market, access to extension services, age, value addition and the quantity of sweet potatoes supplied, while transport mode, land size, quantity of sweet potatoes and gender ensure the participation for the regional option. The research study conducted by Daramola and Oparinde (2014) investigated the determinants of market participation by maize farmers in Ondo State, Nigeria. They found that the age of the household head, experience of the household head, cropping system, quantity of harvested output, farm size, land tenure and unit price of output had significant influence on the intensity of market participation by maize farmers in rural and peri-urban areas of the state. Benin *et al.* (2003) examine the strategy for improving market participation and sales of smallholder livestock producers in Ethiopia. The analysis demonstrates that physical capital (ownership of different species of livestock and landholding) and financial capital (crop income and non-farm income) are the main factors influencing market participation and sales. Jagwe *et al.,* (2010) concluded that agricultural sector in developing countries transforms towards commercialization, smallholder farmers require taking necessary information regarding access to markets, market information, market intelligence and effective farmer organization. While there are many studies regarding the determinants of market participation in other counties, few studies were found for Bangladesh, especially for this study region. The research study operated by Belete *et al.* (2014) aimed to investigate factors affecting the market participation of maize farmer in greater Giyani Municipality using logistic regression model. Empirical result found from the study indicate that gender, farmers access to credit, marital status, market information and infrastructure, were found to be positively significant while distance to market and external source of income were negatively significant. Farmer's level of education and age of farmers were positive but insignificant. Distance to output market, experience in farming, and external source of income were negatively related to market participation. Randela *et al.* (2008) concluded that age, ability to speak/understand English, access to loans, region, ownership of transport, access to market information, distance to market are positively related to market participation while dependency ratio, born in community, land size, ownership of livestock are negatively related to market participation.

An increase in food price in international market over the past few years motivated farmers to cultivate more rice, which in turn increased domestic production. As a result export will increase and balance of payment will improve. Small farmers are often in are adverse position as compared to large farmers to take the advantage of economies of scale in production, access to information, policies such as price supports, input subsidy, market-precipitating services such as extension visitation and credit assistance and these impediments often give rise to low rates of adoption of improved technologies that could potentially increase productivity, which in turn increase market participation. When this is the case it is an open question as to the design of appropriate policies to increase market participation. The objective of the study is to explore and estimate the intensity of market participation in *Gopalganj* district. To capture this objective, the following specific objectives are considered: (i) to determine the socio-economic characteristics of rice farmers in the study area; (ii) to identify the constraints to market participation; (iii) to determine the level of market participation in the study area; (iv) to identify the factors that influencing market participation of rice farmers.

3. Methodology of the Study

3.1 Selection of the Study Area and Data Collection

The present study applies multistage random sampling method with *upazila* the first stage and respondent being the last stage. Thus, *Gopalganj* district was selected purposively. Then the researcher collects two *upazilas* randomly from *Gopalganj* district. One is, *Gopalganj sadar*, which is near the *Gopalganj* district and the other is, *Tungipara*, which is comparatively a remote area. Then from each *Upazila,* one union is selected and thus two unions are selected. After selecting union, two villages are selected from each union and thus four villages have been selected for analysis. At first the list of farmers was collected from the union office, and then 100 farmers were selected randomly. However, for this research some secondary data have also been collected.

Gopalganj district is predominantly agro-based, rice is one of the major crops produced along with other minor crops, such as wheat, oilseeds, maize, vegetables, fruits and spices. Farming is the major occupation of majority of the population and their livelihood almost completely depends on agricultural activities. The location selected for the study is almost a single cropping area where rice is grown extensively and there is a sufficient scope to improve yield through agronomic practices. All these features conform to the characteristics of Bangladesh agriculture and the study area can be considered as the area representative of the research objective.

3.2 The Empirical Model

Indexing was used to measure the level of market participation among respondents in the study area. Additionally, various levels of market participation by farmers in the study area were calculated using the formula below:

Level of market participation = $\frac{RTMPI}{NMPW}\times 100$

Where, $RTMPI$= Frequency of total market participation indices; $NMPW$ =Size of market participants within a given category.

Table 2.1 indicates the basic construction of total market participation index (TMPI) used in calculating the level of market participation. Market participation

Table 3.1 : Market Participation Index

	Market location					*Period of sale*		*Buye*
Quantity sold (kg)	*Home stead (1)*	*Farm gate (2)*	*Village/ rural market (3)*	*Town/u rban market (4)*	*City/ divisional market (5)*	*On season (1)*	*Off season (2)*	*Consu mer (1)*
0	-	-	-	-	-	-	-	-
40-800 (*level I*)	X_1	X_2	X_3	X_4	X_5	X_1	X_2	X_1
801-2000 (*level II*)	X_2	X_4	X_6	X_8	X_{10}	X_2	X_4	X_2
2001-4000 (*level III*)	X_3	X_6	X_9	X_{12}	X_{15}	X_3	X_6	X_3
>4001 (*level IV*)	X_4	X_8	X_{12}	X_{16}	X_{20}	X_4	X_8	X_4

is classified into four categories viz. *level I, level II, level III, and level IV*. *Level I* market participants refer to those that annually sell their product between 40 to 800 kg at market price while *level II* market participants sell at market with 801kg to 2000kg. Similarly, *level III and level IV market participants' sell (2001-4000) kg, and* (4001+) kg. To construct market participation index, farmers are considered to sell their product at five different places, including homestead, farm gate, village market, town market and city market. Consumer and trader are considered as the buyers to construct the market participation index.

Tobit model was used to determine factors influencing market participation. The Tobit regression model is specified below**:**

$$Y_i^* = X_i\beta + U_i$$

Where, Y_i* = latent variable representing levels of market participation: X_i a vector of farmers characteristics felevant in explaining the levels of market participation; β=a corresponding vector of parameters to be extimated; U_i = a homoscedastic, normally distributed error term.

3.3 Specification of the Empirical Model

Following the empirical work of (Alene *et al.* 2008; Omiti *et al.* 2009; Lapar *et al.* 2003; Mauti *et al.,* 2013; Daramola and Oparinde , 2014; Benin *et al.* 2003; Jagwe *et al.,* 2010; Randela *et al.,* 2008) the present study decided to construct and use Tobit model. To determine the shares of the selected variables in the process of market participation, the following specification of the model, in Tobit framework, is applied:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + e_i$$

Where, Y is the level of market participation, X_1= Age, X_2= gender, X_3=Education, X_4= Family size; X_5= Size of output, cooperative membershi , X_6= Training, X_7= Non-farm income, X_8= Cooperative membership, X_9= Extension visit, X_{10}= Market information, X_1=Distance, X_{12}= Price per kg.

β_0 is constant and β_1, β_2, β_3,………….., are regression coefficients and e is the random error, which is normally distributed. The specific variables to be estimated in the model are described in Table 3.2. The expected signs of age, education, size of output, cooperative membership and extension visit are positive, indicating that an increase in each of these variables would increase the level of market participation.

On the other hand, only the distance variable is expected to bear the negative sign. Variables such as gender, family size, training, non-farm income, market information may influence market participation either positively or negatively.

4. Results and Discussion

4.1 Characteristics of the Farmers

The socio-economic characteristics of the farmers studied in the two *upazilas* under *Gopalganj* district are presented in Table 4.1. Sample data shows that the mean age of the farmers is 38.12 years while the modal age group is 35-44 years as depicted in table 4.1. The present study revealed that about 47% farmers were in small category and 31% farmers were in medium category. Only 5% farmer was found to be of the marginal farmer category while 17% farmers were in large category. 95% farmers were found to be married while 5% were unmarried.

Table 3.2 : Exogenous Variables Used in the Tobit Model

Variable	Type	Definition	Measurement	Expected sign
Age	Dummy	Age of the household head	Number of years	+
Gender	Dummy	Gender of the household head	1 if male, o female	±
Education	continuous	Education level of the household head(years of schooling)	Number of years	+
Family size	continuous	Total number of person in the family	Number	±
Size of output	Continuous	Amount of output annually sold by farmer	Kilograms for crops	+
Training	Dummy	Status of farmer whether he received training or not	1 if farmer receive training, 0 otherwise	+
Non-farm income	continuous	Proportion of non-farm income in total monthly household income	BDT (Taka)	±
Cooperative membership	Dummy	Status of farmer whether he received training or not	1 if the respondent is a member, o otherwise.	+
Extension Visit	Dummy	Response of farmers whether agriculture officers come to visit them with information or not	1 if yes, o otherwise.	+
Market information	Dummy	Market information source/arrangement	0 = informal 1 = formal	±
Distance	continuous	Average distance from farm to main point of sale	Kilometers	-
Price per kg	continuous	Average price at which each kg of output is normally sold	BDT (Taka)	+

Table 4.1 shows that, 14% farmers had no formal education and 29% farmers incomplete primary education, while the number of farmers who had taken complete primary and complete secondary education was 37% and 5%, respectively. Only 1% farmer had tertiary education. This could have negative impact on market participation. Among the 100 respondents, 41% farmers are

found to have 1 to 4 family members while 51% farmers had 5 to 10 family members. 8% farmers reported that they had family members above 10. Table also shows that about 13 percent respondents were related with agriculture activities

Table 4.1: Characteristics of the Farmers

Variable	Explanation	Number of observations	Percentage
Farm size (in *Bighas*)	Marginal (0.15-1.49)	5	5
	Small (1.50- 7.49)	47	47
	Medium (7.50-22.49)	31	31
	Large (22.5 and above)	17	17
Gender	Male	95	95
	Female	5	5
Age (in years)	25-34	28	28
	35-44	43	43
	45-55	20	20
	56-64	9	9
Marital Status	Married	87	87
	Unmarried	13	13
Education of the Farmer	No formal education	14	14
	Incomplete primary	29	29
	Primary complete	37	37
	Incomplete secondary	14	14
	Secondary complete	5	5
	Tertiary	1	1
Family size	1-4	41	41
	5-9	51	51
	10-above	8	8
Farming experience (in years)	1-10	13	13
	11-20	17	17
	21-30	45	45
	31-40	25	25
Agricultural co-operative	Member	24	24
	Non-member	76	76
Training	Have training	23	23
	No training	77	77
Access to credit	Receive credit	28	28
	Not receive credit	72	72
Distance to nearest market	1-5	15	15
	6-10	37	37
	11-15	31	31
	16+	17	17
Number of observation		100	100

Source: *Authors own calculation*

for 1-10 years while 17 percent for 11-20 years. The last two categories include 70 percent of the respondents who are related with agricultural activities.

In the nutshell of agricultural co-operatives, it is found that 24% farmers are related with agricultural co-operatives while 76% are without agricultural co-operatives. Only 23% farmers had received agricultural training while 77% farmers were found without agricultural training. Only 28% farmers were seen to get agricultural credit from institutional sources. Again, it is obvious from the study that, 37% and 31% farmers reported that the nearest distance from their residence to market is (6-10) and (11-15) km, respectively.

4.2 Farmers' Perceptions about Constraints Regarding to Market Participation

It is found in the survey that farmers are relatively unaware about constraints to market participation. The present study uses five points Lykerts chart in order to rank the constraints relating to market participation. A higher index value establishes the top ranking of a constraint as compared to lower index value.

Table 4.2 indicates the ranking of constratints relating to market constraints. The farmers in the study area have recognized "weak insfrastucture" as the major market participation constraints (mean index value 3.23) followed by the "Influence of middle man on price" and "Inadequate market information" problems. On the other hand, "weak market monitoring cell", "inequitable market price", "weak transportation facilities" hold 4th, 5th and 6th rank with index values 1.81, 1.47 and 1.41, respectively.

Sub-division and fragmentation of land is considered one of the problems relating to market participation and holds 10th rank with index value 0.45.

4.3 Analysis of Market Participation by Farmers

Table 4.3 presents the level of market participants by small farmers. It is clear from the table that, among 47 small farmers, 9 farmers participate in market by *level I* while 31farmers participate in market *by level II*. The number of farmers who participate in market by *level III* and *level IV* are 5 and 2, respectively.

If we take the percentage of small farmers regarding market participation we see that 19.14%, 65.95%, 10.63% and 4.25% farmers are participating in market by *level I, level II, level III and Level*, respectively.

For medium farmers, majority of the farmers participate in market by level III. Only 3.22% medium farmers participate in market by *Level I* while 16.12% and 12.90% farmers are seen to participate in market by level III and level IV.

Table 4.2 : Ranking of Constraints to Market Participation

Description of the Constraints	Mean	SD	Rank
Weak transportation facilities	1.41	0.712	6
Inadequate market information	2.57	1.071	3
Weak infrastructure	3.23	1.197	1
Weak market monitoring cell	1.81	1.386	4
Sub-division and fragmentation of land	0.45	0.641	10
Lack of agricultural credit	1.38	1.195	7
Influence of middle man on price	2.78	1.068	2
Lack of education	0.86	0.612	9
Long distance to nearest market	1.27	1.358	8
. Unequitable market price	1.47	0.991	5

Source: *Authors' Own Calculation.*

For large farmers, 88.23% farmers are found to participate in market by level IV. The present analysis also indicates that for large farmers 5.88% and 11.76% are seen to participate in market by level II and level III.

Table 4.3 : Analysis of Market Participation by Small Farmers

Level of market participation	*Number of farmers*	*Percentage*
Level I	9	19.14
Level II	31	65.95
Level III	5	10.63
Level IV	2	4.25
Total	47	100

In conclusion, it can be said from the analysis that small farmers are seen to participate in market by *level II* whereas medium and larger farmers are found to participate in market by *level III* and *level IV*.

Table 4.4 : Analysis of Market Participation by Medium Farmers

Level of market participation	*Number of farmers*	*Percentage*
Level I	1	3.22
Level II	5	16.12
Level III	21	67.74
Level IV	4	12.90
Total	31	100

Table 4.5 : Analysis of Market Participation by Large Farmers

Level of market participation	*Number of farmers*	*Percentage*
Level I	00	00
Level II	1	5.88
Level III	2	11.76
Level IV	15	88.23
Total	17	100

4.4 Analysis the Level of Market participation

The present study indicates that out of 100 respondents, only 5 farmers did not participate in market. When the scores between the quantities of produce sold and other indices in the matrix (market location, period of produce sale and buyers) were computed, the minimum score was 3 implying the least participant, while the maximum score was 64 meaning the highest participant. The four levels of market participation (MP) revealed that although 95 sampled farmers participated in the market, they had different levels of participation. It is important to note that 5 did not score up 3 hence were tagged as market non-participants. The various levels of market participation and their scores are as presented in Figures 1 to 4. From the Total Market Participation Index (TMPI) it is found that 11 respondents (11.58%), 17 respondents (17.89%), 32 respondents (33.68%) and 35 respondents (36.84%) of sampled farmers participated in *levels 1, 2, 3, and 4,* respectively.

Factors Influencing Market Participation

In order to see the intensity of market participation, Tobit model is applied. Results found from the Tobit analysis indicate that factors like age, education, size of output, training, cooperative membership, and unit price are positively related to the intensity of market participation.

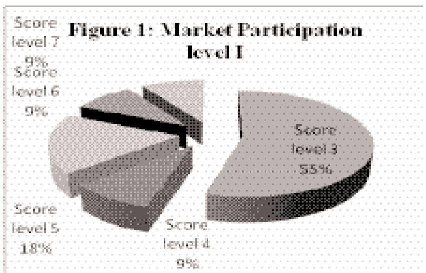


Figure 1: Market Participation level I

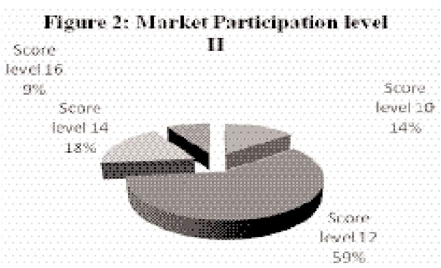


Figure 2: Market Participation level II

Result found from the regression analysis indicates that, a 1 percent increase in age, size of output, training, cooperative membership, and price per kg, keeping all other factors constant, would result an increase in market participation by 0.162, 0.005, 0.052 and 0.002 percent, respectively.

Figure 3: Market Participation level III

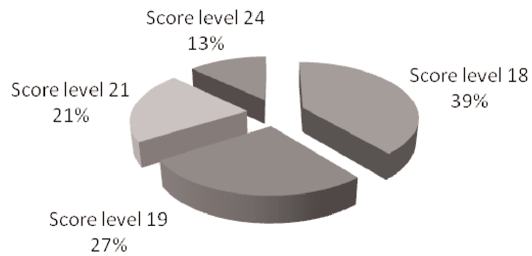
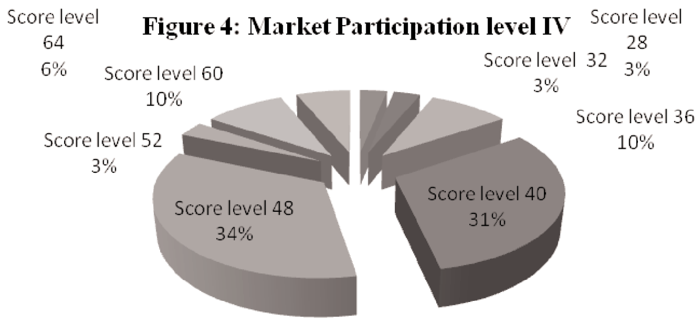


Figure 4: Market Participation level IV



On the other hand, market participation is influenced negatively by gender, education, family size, non-farm income, extension visit, market information and distance. It indicates that, a 1 percent increase in gender, family size, non-farm

Table 4.6 : Result of Tobit Regression

Variable	Coefficient	Z-statistic	Probability
Constant	85.69	5.36	0.0004
Age	0.062*	1.65	0.0962
Gender	-0.042**	-2.41	0.0290
Education	-0.005***	-4.21	0.0001
Family size	-0.035 ***	-3.56	0.0003
Size of output	0.005***	3.46	0.0004
Training	0.052	0.91	0.8983
Non-farm income	-0.025*	-1.46	0.0962
Cooperative membership	0.022***	4.42	0.0009
Extension visit	-0.001**	-2.38	0.0490
Market information	-0.076*	-1.53	0.0812
Distance to nearest market	-0.032***	-3.32	0.0006
Price per kg	0.012***	3.86	0.0003
Log likelihood ratio= -52.03		R^2 = 0.42	

Source: *Authors' Own Calculation*
Note:*,**, and *** indicate the significant level at 10, 5, and 1%, respectively.

income, extension visit, market information and distance, keeping all other factors constant, would result a decrease in market participation by 0.042, 0.005, 0.035, 0.025, 0.001, and 0.032 percent, respectively. Frequency of extension visit should increase the level of market participation. But the coefficient of extension visit found with a negative sigh indicating that an increase in extension visit would reduce the level of market participation. This could be due to less responsibility of extension officers in their duties. The negative sign of education is unexpected which could be due to lack of proper education among the respondents.

5. Conclusion and Policy Recommendation

The major objective of this paper was to identify the factors influencing market participation of rice farmers in *Gopalganj* district, including identifying the constraints to market participation and determining the level of market participation in the study area. The five point Lykert index was used to identify the extent of market participation constraints. Besides, Tobit model was used to identify the intensity of market participation. Results found from Lykert test indicate that "weak insfrastucture" is the major constraint (mean index value 3.23) followed by the "Influence of middle man on price" and "Inadequate market information" problems in the study area. Our inquiry also reveals that small farmers are seen to participate in market by *level II* whereas medium and larger farmers are found to participate in market by *level III* and *level IV.*

Results found from the Tobit analysis indicate that factors like age, size of output, training, cooperative membership, and price per kg are positively related to the intensity of market participation. On the other hand, market participation is influenced negatively by gender, education, family size, non-farm income, extension visit, market information and distance. Based on the findings of this research it is necessary recommend some policies regarding the intensity of market participation. Some of the suggestions emerge from the field survey experiences of this researcher. Based on the findings of the study, the following recommendations can be made:

Due to the huge supply of rice in harvesting period, price is comparatively low than in the non- harvesting period. Farmers are often seen to be losers in this time. Incentives in the form of price support or input subsidy should strictly be put round the year, especially in the harvesting period to encourage farmers to earn better returns for their effort. If this programme can be ensured, it will give incentive to farmers to expand rice production as well as market participation.

- Due to the intervention of middleman, farmers often fail to get the fair price of their produce. Government can take appropriate step to reduce the influence of middleman in the market. In this regard, a market monitoring cell can be formed.
- Farmers should be motivated to form cooperative societies with the intension of selling their product at fair price. This will inspire the farmers that ultimately enhances market participation. Government should encourage formation of local or community associations where farmers can have a common voice, get information about market situation and assist one another via collective works.
- Effort should be geared at improving the status of rural infrastructures, especially road network. Investment in rural road infrastructure would lead to more traders penetrating the rural areas and this will increase competition and could benefit farmers through higher prices.
- Government should take necessary initiatives to spread market information among farmers through Radio, TV, newspaper and extension officers.

References

1. Adeoti *A.I.,* Oluwatayo I.B, Soliu, R.O., 2014. Determinants of Market Participation among Maize Producers in Oyo State, Nigeria. *British Journal of Economics, Management & Trade, 4(7): 1115-1127.*
2. Alene, A. D., Manyong, V. M. Omanya, G. Mignouma, H.D. Bokanga, M. and Odhiambo, G., 2008. Smallholder Market Participation under Transactions costs: Maize Supply and Fertilizer Demand in Kenya. Food Policy 33, 318–28.
3. Belete, A., Ledwaba,L.J., Hlongwane, J.J.,2014. Analyzing the factors affecting the market participation of maize farmer: A case study of small-scale farmers in great Giyani local Municipality of the Mopani District, Limpopo Province. African Journal of Agricultural Research. Vol 9 (10), pp.895-899.
4. Benin, S., Ehui, S. and Paulos. Z., 2003. "Policy Options for Improving Market Participation and Sales of Smallholder Livestock Producers: A Case Study of Ethiopia". Paper presented at International Conference on African Development Archives. Western Michigan University, 2003.
5. Borbala, B. and Wobst P., 2005. "Institutional factors and market participations: The case of Romania". *International Food Policy Research Institute*, 48:223-224.
6. Daramola, G.A. and Oparinde, O.L. 2014. "Determinants of Market Participation by Maize Farmers in Ondo State, Nigeria". *Journal of Economics and Sustainable Development,* 5(1), pp.69-77.
7. FAO., 2004. *FAO Production Year Book*, 2004. Food and Agricultural Organization of United States, Rome.
8. Goetz S.J., 1992. "A Selectivity Model of Household food marketing behavior in sub-saharan Africa". *American Journal of Agricultural Economics, vol*. 74(2), pp. 444-452.
9. Holloway, G.J., Nicholson, C., Delgado, C., Staal, S., Ehui, S., 2000. "Agroindustrialization through Institutional Innovation: Transactions costs, cooperatives and milk-market development in the East African Highlands". *Agricultural Economics*, 23, 279–288.
10. IFAD (International Fund for Agricultural Development), (2003), "Promoting market access for the poor in order to achieve the Millennium Development Goals". IFAD, Roundtable Discussion Paper for the 25th Anniversary Session of IFAD's Governing Council.
11. Jagwe J, Machethe C. and Ouma E., 2010. "Transaction costs and smallholder farmers' participation in banana markets in the Great Lakes Region of Burundi, Rwanda and the Democratic Republic of Congo": *African Journal of Agricultural and Resource Economics* 6 (1). Pp.45-53.

12. Key. N., Sadoulet, E., and Janvry D. A., 2000. "Transaction cost and Agricultural supply response". *American Journal of Agricultural Economics*, Vol. 82. Pp. 245-259.

13. Lapar, M.L., Holloway, G. J. and Ehui, S., 2003. "Policy Options Promoting Market Participation among Smallholder Livestock Producers: A Case Study from the Phillipines". *Food Policy*, 28, pp. 187–211.

14. Latt. E.A., And Nieuwoudt W.L., 1988. "Identification of plot size effect on commercialization small-scale agriculture in Kwazulu". *Development Southern Africa*, vol 5(3), pp.371-382.

15. Makhura M.T., Goode M.F., and Coetzee G.K., 1997. "Indexing participation in the market economy through factor analysis: Implications from food security". *Agrekon*, vol, 36(4), pp.473-783.

16. Mauti, K.B., Agunda, N.E. Muluvi S. A. Kibet, K. L. and Maina. M.C., 2013. "Determinants of Smallholder Sweet Potato Farmers' Participation in Different Market Options: The case of Vihiga County, Kenya". *Journal of Development and Agricultural Economics*, vol. 5(8), pp. 314-320.

17. Omiti, J., Otieno. N. Nyannamba, T. and Mccullough. G., 2009. "Factors Influencing the Intensity of Market Participation by Smallholder Farmers: A case Study of Rural and Peri-urban areas of Kenya". *Afjare*, 3 (1), pp.57-82.

18. Randela, R., Alemu, Z.G & Groenewald, J.A., 2008. "Factors Enhancing Market Participation by Small-scale cotton Farmers". *Agrekon*, Vol. 47(4),pp.458-469.

19. Staal S., Delgado C. and Nicholson C. (1997). "Small holder dairying under transaction cost in east Africa". *World development*, vol.25(5),pp. 779-794.

20. World Bank, (2008), *World Development Report: Agriculture for Development*. World Bank, Washington, DC.

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 253-261
Bangladesh Economic Association
(ISSN 2227-3182)

Climate Change and its Impacts on Rice Production in Western Bangladesh: An Econometric Analysis

MD. ABDUL WADUD*
BHABATOSH ROY**

Abstract *Many studies have been done about climate change and its impacts in the developing countries. However, scant attention has been given to explore the impacts of climate change on rice production in Bangladesh. This study provides a quantitative investigation concerning the relationships between rice production and climatic variables in the western Bangladesh applying a Crop Yield -Weather Regression model. The production model helps estimate the causal influence of climatic variables on rice production. We use secondary data for the period 1972 to 2010.This study further conceptualizes against the backdrop of the increasing climatic problems associated with rice production. Results from the econometric analysis confirm that most of the climatic variables affect rice production; while some of the variables, like humidity and wind speed affect positively and significantly, others like temperature and average sunshine affect rice production negatively.*

1. Introduction

Rice production is very important to Bangladesh economy. In 1991, 10.3 million hactares – almost 80% of the country's total cropped area – was planted for rice. For many Bangladeshi farmers, this crop is their only source of cash income and livelihood. But rice yields average only 2.7 tonne/hactare and the current growth in production is too low to keep up with the 1.9% annual population growth rate

* Corresponding author. Professor, Department of Economics, Rajshahi University, Rajshahi 6205, Bangladesh. Email: wadud68@yahoo.com

** Former Post-graduate Student, Department of Economics, Rajshahi University, Rajshahi 6205, Bangladesh

and the increased demand for rice (BER, 2011). Recent projections indicate a world rice food need of about 765 million tonnes in 2025. In Bangladesh, rice provides 75% of the calories consumed (BER, 2013).

Bangladesh, once known as "The Golden Bengal" having an area of about 144000 km² of the fertile deltaic plain of the mighty rivers – the Ganges, the Brahmaputra, and the Meghna, and their tributaries, was considered as a granary for centuries. However, the scenario of Bangladesh agriculture has changed in recent decades making it a country of recurring deficits since her food production fails to keep pace with human growth of about 1.9 percent (BER, 2011) per annum. Since liberation in 1971, Bangladesh has been trying hard to improve this situation, making considerable stride to attain food self – sufficiency, but still it remains an elusive goal.

Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) published in early 2007 leaves no doubt that the Earth's climate is changing in a manner unprecedented in the past 400,000 years. The report corroborated previous scenarios that by 2100 mean planet-wide surface temperatures will rise by 1.4 to 5.8 °C, precipitation will decrease in the sub-tropics, and extreme events will become more frequent (IPCC, 2007). However, changes in climate are already being observed—the last 60 years were the warmest in the last 1000 years and changes in precipitation patterns have brought greater incidence of floods or drought globally. In quantitative terms, IPCC estimates that, by 2050, changing rainfall patterns with increasing temperatures, flooding, droughts and salinity (in coastal belt) could cause decline in rice production in Bangladesh by 8 per cent and wheat by 32 per cent, against 1990 as the base year (MoFE, 2008). The recent estimates using different models with changed assumptions predicts reduction in production by 1.5-25.8 per cent for aus rice, and 0.4-5.3 per cent for aman due to the effect of high temperature for 2050. For boro rice, production could be increased by 1.2-9.5 per cent, assuming the temperature would not exceed the 35 C threshold limit for rice production (Karim, Hussain, and Ahmed, 1996,).

Bangladesh Climate Change Strategy and Action Plan (BCCSAP, 2009) reveals, rainfall will increase resulting in higher flows during the monsoon season in the rivers, which flow into Bangladesh from India, Nepal, Bhutan and China. Global warming will result in mean sea level rises between 0.18 and 0.79 meters, which could increase coastal flooding and saline intrusion into aquifers and rivers across a wide belt in the south of the country, although most of the area is protected by polders. Rainfall is predicted to become both higher and more erratic, and frequency and intensity of droughts are likely to increase, especially in the drier northern and western parts of the country. Bangladesh is ranked as one of the most vulnerable countries to tropical cyclones and sixth most vulnerable country to floods (MoEF, 2008). The BCCSAP report says that there will be increasingly frequent and severe floods, tropical cyclones, storm surges, and droughts, which will disrupt and displace millions of people from coastal regions, making them 'environmental refugees', unless existing polders are strengthened and new ones are built.

Negative impacts of climate change on Bangladesh agriculture as reported in various documents can be summarized as follows; (i) extended flooding of arable land narrows scope for crop production, especially in the vast low land areas; (ii) increased temperature leads to increased evapotranspiration and droughts, causing water scarcity for irrigation and domestic uses in north-west Bangladesh; (iii) increased inundation and salinity intrusion limit crop cultivation with the existing varieties, especially in the coastal regions. Loss in terms of land degradation and arsenic contamination of soil and water becomes a major concern (Heikens, 2006; Ahmed, 2007); (iv) increased intensity of flush floods in Meghna basin and north eastern Haor region damages standing boro rice crop; (v) increased loss of land to river erosion reduces land-based livelihood opportunities, and increased drainage congestion and water logging due to sedimentation of rivers limit production options for the char dwellers.

These changes are driven by increasing concentrations of greenhouse gases, namely CO, CH and N2O, and will also affect agro-climatic conditions for food production systems. The potentially beneficial effects of increases in CO may be offset by concomitant temperature stress and other factors such as the increases in ground level (tropospheric) ozone concentrations. Most developing countries are not well prepared to deal with the negative impacts to be expected as a result of climate change and are therefore most vulnerable to its consequences.

Agriculture is always vulnerable to unfavorable weather events and climate conditions. Despite technological advances such as improved crop varieties and irrigation systems, weather and climate are important factors because these play significant role to agricultural productivity. The impacts of climate change on agricultural food production are global concerns and concerns specially for Bangladesh, where lives and livelihoods depend mainly on agriculture, and Bangladesh is one of the most vulnerable countries due to these change.

Bangladesh has a large agrarian base with 76 percent of total population living in the rural areas and 90 percent of the rural population are directly related with agriculture. Increasing food production and attaining food security in Bangladesh require sustainable growth in agricultural sector. The agriculture's contribution to gross domestic product is about 20 percent to Gross Domestic Product (BER, 2011). In the agricultural sector 48.1 percent of the country's labor force are engaged, who are always vulnerable to changing climate conditions and unfavorable weather events. The sector is already under pressure for increasing food demand, problems associated with agricultural land and water resource depletion. The issues of climate change make the pressure more acute for the sector (BER, 2011).

Rice is the staple food for above 150 million people. Total population will become 233.2 million by 2050. Therefore, it is imperative to increase rice production in order to meet the growing demand for food emanating from population growth. The diverse climatic phenomena like cyclone, drought, changing rainfall patterns and temperature cause a significant loss in food grain production in every year. For example, two rounds of floods and devastating cyclone SIDR in 2007 and cyclone Aila in 2009 caused severe damages in agriculture production, especially the rice production. Therefore, the challenges faced by the agricultural sector from the climatic conditions require systematic integration of environmental and economic development measures for a sustainable agriculture growth.

With more than sixty percent of its labour force dependent on climate sensitive activities such as agriculture, the impacts of climate change on agriculture assume significant importance for Bangladesh. Sustainability of agricultural production systems in Bangladesh are already challenged by declining land and water resources, high input and energy costs, increasing food prices, depressing effective demand by the poor, slow technology generation and so on. On top of all these, challenges of climate change as indicated by floods, droughts, cyclones etc. are superimposed, meaning that the country will be exposed to a range of disaster risk and vulnerability and that the ongoing efforts to reduce poverty and hunger might be slowed to some extent. Therefore, it becomes imperative to assess the effects of agro-climatic factors on rice production in western Bangladesh, Rajshahi district.

2. Data and Theoretical Framework

Estimation of the model requires crop- yield data and data on a number of agro-climatic variables. While yield data are data of different varieties of rice and total production of rice, agro-climatic data include data on maximum and minimum air temperature, rainfall, humidity, sunshine and wind speed. Yield data are collected from Bangladesh Statistical Yearbook, Bangladesh Bureau of Statistics. Data of agroclimatic variables are obtained from the Bangladesh Meteorological Department.*

The variable of yield of rice and the agro-climatic variables are conceptually related as follows:

$$Y = f(MAX, MIN, AAR, AAH, ASH, AWS) \quad (1)$$

Where, Y = Yield of the rice crop; MAX= Maximum Temperature; MIN= Minimum Temperature; AAR= Annual Average Rainfall; AAH= Annual Average Humidity; ASH= Annual Average Bright Sun-shine Hour; AWS= Annual Average Wind Speed.

3. Empirical Model

There are many empirical studies on the relationship between rice production and climatic variables. In this study, multiple regression model is used to evaluate the relationship between rice production and climatic variables. The explanatory variables included in the model were maximum temperature (MAX), minimum temperature (MIN), annual average rainfall (AAR), annual average humidity (AAH), Annual average sun-shine hour (ASH) and average wind speed (AWS). The yield forecasting model used in this study is specified as:

$$\gamma_i = \beta_0 + \sum_i^n \sum_j^k + \beta_j \; w_{jj} 1, 2, 3, \ldots, \; n \text{ and } j = 1, 2, 3, \ldots, k$$

Where, is the yield of the rice crop, w is the agro-climatic variables, b are the coefficients of the relevant variables, is the constant and is the disturbance term.

Rice production depends on the agro-climatic factors. In this model, we show the influence of explanatory variables on rice production.

* The nature of data obtained from the BMD constrains estimation of the model in both spatial and temporal dimensions. As for the spatial dimension, BMD does not have its weather stations in all the district locations. Again, while a given set of districts are covered in recording data with respect to some variables, other districts are not covered for recording data for the same variables. A preliminary assessment revealed that while data on rainfall, temperature and sunshine hours are recorded at 23 stations, information on evaporation is available from 12 stations and those for solar radiation is recorded at only 7 stations. On the temporal dimension, it is revealed that data on all the variables were not available for the same length of periods. These circumstances required a great deal of adjustment in the estimation of the model, particularly in respect of incorporation of variables in the model.

4. Descriptive Statistics of the Variables Used in the Model

The variables included in the model are presented in Table 1, together with their descriptive statistics. We use secondary data for Rajshahi district from 1972 to 2010. These include maximum and minimum values of all variables, their mean and standard deviation.

Table 1: Descriptive Statistics of the Variables

Variable	Mean	Maximum	Minimum	Standard.Deviation
Yield (Aus)	133385.03	196795	84331	29604.116
Yield (Amon)	544425.69	853070	142351	202951.002
Yield (Boro)	474595.51	1274843	63020	386799.053
Yield (Total)	13821769	3050000	545000.00	698235.8394
Maximum temperature	35.94	39.20	32.20	1.69282
Minimum temperature	10.90	13.80	8.40	1.20110
Annual average rainfall	126.35	186.75	70.25	23.45899
Annual average humidity	77.1026	82.00	72.00	2.60359
Annual average sun-shine hour	6.9308	8.00	5.30	.51817
Annual average wind speed	2.4051	5.40	.90	.97978

From Table 1, it is found that average yield of Aus rice is 133385.03 metric tonnes with the maximum yield of 196795 metric tonnes and minimum of 84331 metric tonnes. Average yield of aman rice is 544425.69 metric ton with the maximum and minimum yield of 853070 and 142351 metric tonnes, respectively. The average yield of Boro rice is 474595.51 metric tonnes with the maximum yield of 1274843 and 63020 metric tonnes, respectively. It is also evident that the average yield of aus, aman and boro aggregately (total rice) is 13821769 metric tonnes with maximum and minimum yield of 3050000 and 545000.00 metric tonnes, respectively. Average maximum temperature is 35.94C with the maximum of 39.20C and minimum of 32.20 C. The average value of minimum temperature is 10.90C with the maximum value of 13.80C and minimum value of 8.40C. The average value of yearly rainfall is 126.35 millimeter with the maximum value of 186.75 millimeter and minimum value of 70.25 millimeter. The average value of yearly average humidity is 77.10 percent with the maximum value of 82.00 percent and minimum value of 72 percent. The average value of yearly bright sun-shine hour is 6.93 with the maximum value of 8.00 and minimum value of 5.30. The average value of yearly average wind speed is 2.41 knots with the maximum value of 5.40 knots and minimum value of .90 knots.

5. Regression Results

Estimation results of the regression equation for aus rice, aman rice, boro rice and total rice production are presented in Table 2. These results provide the estimated coefficients of the explanatory variables, each of which explains the climatic impact of the concerned explanatory variable on rice production expressed in terms of rice yield. The coefficients give elasticity of climatic impact with respect to the individual explanatory variables.

Table 2: Estimated Regression Results of the Crop Yield -Weather Regression Model

Aus Rice		Amon Rice		Boro Rice		Total Rice	
640775.63	2.8390	-3348541.48	-2.0040	-5149223.91	-1.7590	-5954753.08	-1.2760
-151.19	-0.0500	-5623.77	-0.2520	35851.26	0.8980	49010.91	0.7860
-383.03	-0.0930	9694.78	0.3200	-43791.81	-0.7870	-24135.52	-0.2850
91.83	0.4640	869.18	0.5930	1048.98	0.4060	-4183.48	-1.0220
-6169.61	-3.2070	42235.49	2.9660	57113.02	2.2780	109812.34	2.7610
-8879.71	-0.9800	81042.29	1.2090	101519.56	0.8470	-200654.73	-1.0710
11580.36	2.6680	25548.16	0.7950	-170303.99	-2.8260	-294554.74	-3.2820
R^2	F	R^2	F	R^2	F	R^2	F
0.382	3.291	0.279	2.067	0.407	3.199	0.525	5.895

From Table 2 it is evident that maximum temperature has negative and insignificant impact on Aus rice production at 5% significance level. Minimum temperature has also negative and insignificant impact on Aus rice production. Annual average rainfall has positive but insignificant impact on Aus rice production. Annual average humidity has negative but significant impact on Aus rice production. Annual average bright sun-shine hour has negative and insignificant impact on Aus rice production. Annual average wind speed has positive and significant impact on Aus rice production at 5% significance level. It is also evident from Table 2 that both maximum and minimum temperatures have negative impacts on Aus yield, although the coefficients were not statistically significant. The R and F values of the equation were relatively lower indicating that the agro climatic variables in the model may not have been adequately explained.

Aman rice includes local, transplanted aman and HYV aman. It is evident that high day temperature and low night temperature contribute to yield of aman rice. Table 2 shows that, maximum temperature has negative and insignificant impacts on aman rice production at 5% significance level. Minimum temperature and annual average rainfall has positive but insignificant impacts on aman rice production. But annual average sun-shine hour has positive and significant impacts on aman rice production. On the other hand, annual average wind speed has positive but insignificant impacts on rice production at 5% significance level.

Boro production is influenced by climatic variables, such as, maximum and minimum temperature, rainfall, humidity, bright sun-shine hour and wind speed. Regression results of Boro rice are also represented in Table 2. Among the climatic variables, maximum temperature has positive and insignificant impact on boro rice production. But minimum temperature has negative and insignificant impact on boro rice production at 5% significance level. Annual average rainfall has positive and insignificant impacts on boro rice production. On the other hand, annual average humidity has positive and significant impact on boro rice production. Annual average bright sunshine hour has positive and insignificant impacts on boro rice production. Annual average wind speed has negative but significant impacts on boro rice production.

In order to assess the impacts of climatic variables on rice productivity, regression is run between total rice production and those variables and results are presented in Table 2. The results indicate that the explanatory variables have differential impact on rice production. Results show that all the six variables have significant estimated coefficients. Maximum temperature has positive and insignificant impacts on total rice production at 5% significance level. Minimum temperature has negative and insignificant impact on total rice production. Annual average rainfall has negative and insignificant impacts on total rice production. Annual average humidity has positive and significant impacts on total rice production. Annual average sunshine hour has negative and insignificant impact on total rice production. Annual average wind speed has negative but significant impacts on total rice production. The R and F values of the equation are relatively lower indicating that the agro-climatic variables in the model may not have sufficient explanatory power.

6. Conclusion

The study evaluates the impact of climate change on rice production in western Bangladesh using secondary data from 1972 to 2010 for Rajshahi district and applying a Crop Yield -Weather Regression model. In depicting the climate change impact, the rice productions are investigated in terms of maximum and minimum temperature, average rainfall, sunshine hour, average humidity. We investigate the impact on aus, aman, boro rice production separately and on total rice production. Results reveal that the climatic factors have mixed and varying effects on aus, aman, boro rice production and on total rice production.

References

1. Ahmed, I., 2007, Bangladesh: Problems of Global Warming, Land Inundation and Arsenic Poisoning, Paper presented at Ohio State University, Ohio, New Orleans, 02-05 November 2007.

2. BCCSAP, 2009, Bangladesh Climate Change Strategy and Action Plan, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

3. BER, 2011, Bangladesh Economics Review, Finance Divison, Ministry of Finance, Government of the People's Republic of Bangladesh.

4. Heikens, A., 2006, Arsenic Contamination of Irrigation Water, Soil and Crops in Bangladesh: Risk Implication for Sustainable Agriculture and Food Safety in Asia. FAO Regional Office for Asia and Pacific, Bangkok.

5. Hussain, Sk. G., 2008, Assessing impacts of climate change on cereal production and food security in Bangladesh, Paper presented at the International Conference on Global Climate Change and its Effects, held in Dhaka on August 25-30, 2008.

6. IPCC, 2007, Climate Change 2007, Synthesis Report, An Assessment of the Intergovernmental Panel on Climate Change (IPCC), IPCC Plenary XXVII, Valencia, Spain

7. Karim, Z., Hussain, S.G. and Ahmed, M., 1996, Assessing impacts of Climatic Variations on Foodgrain Production in Bangladesh, Water Air and Soil Pollution, 92, 53-62.

8. MoEF (Ministry of Environment and Forest), 2008, Bangladesh Climate Change Strategy and Action Plan, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

Bangladesh Journal of Political Economy

© 2013 Bangladesh Journal of Political Economy
Vol. 29, No. 1, June 2013, pp. 263-278
Bangladesh Economic Association
(ISSN 2227-3182)

An Analysis of Productivity and Profitability of Rice Farm in Bangladesh: A Study of Sylhet District

Mohammad Mizanul Haque Kazal*
M. Moazzem Hossain Khan**
Md. Selim Reza***

Abstract *The field visits of Sylhet District has shown that only a small fraction of farmers grow four crops per year in their land and most of them grow only one crop in their land in a crop year. Therefore, in this study, an investigation has been made to find out the input productivity and profitability of rice farm in Sylhet District. In total 120 farmers were selected randomly from three thanas of Sylhet District, where equal number of samples were collected from each thana. Data were collected through farm survey by using a suitable pre-tested questionnaire. Cobb-Douglas Production Function and Profit Function and statistical test (t-test) are used for analysis. It is seen from the study that there is profit from two categories of rice on three categories of farm but in the case of power tiller operated farm the inputs cost are very high. For this reason, the profit is less in power tiller operated farm compared to animal operated farm. To find out productivity and resource use efficiency we used Cobb Douglas production function. The use of fertilizers is statistically significant at 1%, 5%, and 10% level of significance for all categories of farms. The use of inputs like human labour, seed, irrigation, insecticides, power tiller/animal power are also statistically significant but not for the two crops.*

Introduction

Agriculture is the most important sector in the economy of Bangladesh as it contributes about 19.68% of the gross domestic product (GDP) and 47.5% of

* Professor and Chairman, Department of Development and Poverty Studies, Sher-E-Bangla Agricultural University, Dhaka
** Professor, Department of Economics, University of Rajshahi, Rajshahi, Bangladesh
*** Assistant Professor, Department of Economics, University of Rajshahi, Rajshahi, Bangladesh

overall employment (BBS, 2013). Though the direct contribution of the agriculture sector has decreased gradually, it has indirect contribution to the overall growth of GDP. The growth of broad services sector, particularly the growth of wholesale and retail trade, hotel and restaurants, transport and communication sector, is strongly supported by agriculture sector. In FY 2010-11, Bangladesh earned US$ 1316 million by exporting agricultural products which was 5.74% of total export earnings (US$ 22924 million) (Bangladesh Economic Review, 2011). Bangladesh agriculture consists of two broad sub-sectors namely agriculture & forestry and fishery. In agriculture & forestry there are again three sub-sectors like crops and vegetables, livestock and forestry. Among these sub-sectors crops and vegetables is the largest sub-sector in our agriculture.

The dominant food crop of Bangladesh is rice. Rice accounts for 94% of the cereals consumed, supplies 68% of the carbohydrate in the national diet, accounts for approximately 78% of the value of agricultural output, and 30% of consumer spending (Ahmed *et al.,* 2000). It also accounts for 93% of the total crops produced (Bangladesh Economic Review, 2012) and 76.62% of the cropped area (BBS, 2006). In Bangladesh 88.44% of the total households are located in rural areas and they are more or less dependent on agriculture for a living (Bangladesh Agricultural Census, 2008). Agriculture provides the basic food for the survival of the subsistence farmers in Bangladesh. Subsistence farmer account for the greatest proportion of those engaged in farming. Bangladesh agriculture already operates at its land frontier and there is little or no scope to expand the cultivable land to meet the increasing demand for food requirements for its ever-increasing population. (Rahman, 2003). Moreover, high population growth, frequent crop failures resulting from flooding (*Sidr* in 2007) or droughts put pressure for intensification of land use. So, it is very hard for this country to increase the productivity of its limited 8.44 million hectare arable lands (BBS, 2006).

The *slogan* of Bangladesh Rice Research Institute is “Rice is the lifeblood of Bangladesh”. In Bangladesh, three rice crops are grown during the crop cycle beginning in April – the *Aus* (Spring) crop, the Aman (summer) crop, and the Boro (winter) crop. The monsoon rice Aman harvested in November-December is the main rice crop. It occupied 5.7 million hectares in 2002-03, approximately 53% of the total rice area. On land with shallow flooding depth Aman is transplanted with shorter duration varieties, but on deep flooded land Aman is directly seeded as an upland crop from June to July. Then the plant grows with flood water from June to September, and is harvested in November after the flood water recedes. Bangladesh receives about 400 millimeters of rain during the pre-monsoon months of March to May, which farmers use to grow a short-duration drought-resistant crop known as Aus, which gives a yield of about 1.8 ton/hectare. The crop is mostly directly seeded during March-April and harvested in July-August. In 1969-70 the crop occupied 3.4 million hectares, but the area declined to 1.2 million hectares by 2002-03 as farmers shifted the land to vegetables or dry season irrigated rice called Boro. Boro was used to be grown in very low land (not suitable for growing any crop during the monsoon season), and transplanted in November after the recession of the flood and harvest in April – May. However, with the spread of the ground water irrigation, the area has expanded to all land types, and is now mostly transplanted in January-February and harvested in May-June. The area has expanded from 0.5 million hectares in 1969-70 to 3.8 million hectares in 2002-03, which is 35% of the total rice area.

Sylhet is a mono cropped area where almost all the farmers cultivate Aman crop due to frequent and heavy rainfall in monsoon. The second highest rice crop grown in Sylhet district is Boro crop. Inspite of the high risk of early flood, farmers cultivate Boro crop in haor area, which is very fertile for siltation. Due to soil type and weather Sylhet district is not suitable for growing other crops like wheat, jute, pulses, sugarcane and vegetables. Large portions of farmers of this district cultivate rice to meet their family need and they are not interested for surplus production. Sometimes, land owners lease their land on contract basis called fixed-rent contract, one in which the landlord charges a sum of money per year or per season for the rental of the land and, in turn, allows the tenant to carry out production. The other type of contract is commonly referred to as sharecropping, which means the sharing of the tenant's output in some pre assigned proportion between the landlord and the tenant. Farmers of the study area are not aware about their input productivity and profitability in rice production. People of this area have a higher tendency to migrate abroad and the remaining family members have no interest in farming. So, labour shortage is a common problem of this district and hiring labour with high wage increased production cost. Three types of farms like animal operated, power tiller operated and animal plus power tiller (pooled) operated farm were shown in the study area but it is very expensive to use animal power in ploughing deep wetland. Using machinery (power tiller, shallow machine and thresher) helps to increase the cropping intensity by providing temporal and partial adjustment in crop production activities so that least time is lost between the crops and the farmer is able to raise more number of crops in a given time and is also able to reduce his cost. The post-harvest operation like threshing is undertaken; using machines not only reduces the losses but also improves the quality of the product. It is known to all that the literacy rate of Sylhet district is very low compared to other districts and the education level of the farmers is not in satisfactory level. Due to the lack of education farmers of this area cannot use High Yield Variety (HYV) seeds, fertilizer and insecticides properly. But we know education has a positive impact on resource use efficiency. So, it is clear that there is a great chance to increase productivity and profitability of rice farm in Sylhet district.

Thus, keeping in view the importance of the study of input productivity and profitability of rice farm, the following objectives were formulated.

- To identify the input productivity of different categories of rice farm;
- To measure the profitability of rice production in different categories of farm;
- Develop some policy suggestions on the basis of findings.

Review of Literature

The problems experienced in this area are mostly location and region oriented, which demands a continuous study on the part of researchers. It is, therefore, not surprising that apart from the massive amount of research work done by individuals and organizations, there have been frequent demands from the policy makers to undertake further specific studies in this area. Hence the important work carried out on this aspect is reviewed comprehensively to understand the direction of research carried out so far and to evolve a possible improvement over such available studies.

Duft (2003) pointed out the reduction of wage employment opportunities in farming due to farm mechanization which diverted labour to other forms of employment in non-farm activities or leisure activities. Pandey (2004) argued that farm equipment are used in farming operations, including immediate post harvest activities, with a view to increasing productivity of land and labour through timeliness of operations, for efficient use of inputs, improvement in quantity of production and safety and comfort of farmers, and reduction in loss of produce and drudgery of farmers. Power tiller mounted implements such as mould board ploughs, disc ploughs, cultivators and other crop-specific equipment are widely being used for seed bed preparation. Seed drills and planters, both animal drawn and Power tiller mounted, have become popular. Mechanization transplanters for rice and vegetables crops are catching up with farmers. Hossain *et al.* (2006) reported that technological progress helped Bangladesh to achieve self-sufficiency in rice production in 2001 from a heavy import-dependence, despite doubling of population and a reduction in arable land since its independence in 1971. As the adoption of modern varieties (MV) of rice is reaching a plateau, particularly for the irrigated ecosystem, an important issue is whether the research system will be able to sustain the growth of production.

Majumder *et al.* (2009) attempted to measure and compare resource use efficiency and relative productivity of farming under different tenure conditions in an area of Bhola district. The study explored the difference in the efficiency and productivity among owner, cash tenant and crop share tenant. Total cash expenses as well as total gross costs for producing HYV Boro rice was the highest in owner farms and lowest in crop share tenant's farm. When individual inputs were considered it was observed that expenses on human labour shared a major portion of expenses in the production of HYV Boro rice where owner operators used more hired labour in comparison to other groups. However, the cash tenant farmers were more efficient than owner and crop share tenant farmers. Due to poor resource base the crop share tenants were unable to invest on modern farm inputs. It may be mentioned that in Bangladesh the predominant tenancy arrangement is share cropping, which is an inefficient form of tenure arrangement compared to cash tenancy.

Methodology

A micro-level study based on primary cross-section data was designed to attain the objectives of this study. The methodology of the study is mainly about the sampling procedure, collection of data and analytical framework used.

Sampling

This study was conducted in Sylhet District. It comprises of twelve thanas – Sylhet Sadar, Gowainghat, Fenchuganj, Bishwanath, Balagonj, Beanibazar and South Surma, Zakigonj, Golapgonj, Jaintapur, Companigonj and Kanaighat. For collecting data, a three-stage stratified random sampling design was used. In the first stage, three thanas were selected from the list of all thanas in the Sylhet District. In the second stage, two unions were randomly selected from each selected thana. In the third stage, two villages were selected from each selected union using random sampling technique. To collect data on land area, production of rice, and costs and returns of rice production, 10 farmers were selected from each village. To select the village, priority has been given to those areas where large numbers of farmers were engaged in rice production.

Since the study focuses on input productivity in a predominantly rice grown area, attempt was made to choose the villages, which had an average level of agricultural performance in their respective sub-regions. Relevant information was collected from thana agricultural office.

Data Collection

Following the conventional survey techniques, primary data on resource availability and their use, input-output levels, prices of farm production and inputs as well as some other relevant information were collected by interviewing the farmers personally using a suitably designed and pre-tested questionnaire.

Secondary data on location, climate, soil, irrigation, major crop enterprises, population, land utilization pattern, insecticides and fertilizer consumption of the study area were compiled from several publications such as Statistical Year Book of Bangladesh (2010), Report of the Household Income & Expenditure Survey (2010), Bangladesh Economic Review (2012), Report on Labour Force Survey (2010) etc.

Analytical Framework

Resource Productivity

Cobb-Douglas production function was used to estimate the effects of various inputs employed for the production of rice in three categories of farms (animal operated farms, power tiller operated farms, animal plus power tiller operated farms). Six independent variables, namely human labour cost, seed cost, fertilizer cost, irrigation cost and land preparation cost were taken into consideration, which are likely to have an impact on production of two varieties of rice (Aman and Boro). All variables were expressed in monetary terms. The land use cost as a variable has not been considered, because this cost was fixed per hectare for all farmers for producing rice. To determine the contribution of the most important variables in the production process, the following specification of the model was applied:

$$Y_{ij} = a \quad X_{ij1}^{b_1} \quad X_{ij2}^{b_2} \quad X_{ij3}^{b_3} \quad X_{ij4}^{b_5} \quad X_{ij5}^{b_5} \quad X_{ij6}^{b_6}$$

In log-linear form the above function can be written as:

$$lnY_{ij} = lna + b_1\, lnX_{ij1} + b_2\, lnX_{ij2} + b_3\, lnX_{ij3} + b_4\, X_{ij4} + b_5\, X_{ij5} + b_6\, X_{ij6}$$

Where,

Y_{ij} = per hectare output of ith crop on jth type of farm,

X_{ij1} = human labour used (work days) per hectare for ith crop on jth type of farm

X_{ij2} = value of manures and fertilizers per hectare for ith crop on jth type of farm

X_{ij3} = value of seed per hectare for ith crop on jth type of farm,

X_{ij4} = cost of irrigation per hectare for ith crop on jth type of farm

X_{ij5} = cost of animal or power tiller or both per hectare for ith crop on *jth* type of farm,

X_{ij6} = cost of insecticide per hectare for ith crop on jth type of farm,
a = technical efficiency coefficient,
$b_1, b_2, \ldots$ = production elasticity of the corresponding inputs

Profit Function

Profits for each of the individual crops in the three categories of farms (power tiller, animal and animal plus power tiller operated / pooled) were calculated separately. The activity budget as suggested by Dillon and Hardaker (1980) was employed for deriving the profit equation. The profit equation of the following from was used:

$$\pi_1 = P_{yi}.Y_i + Pb_i.B_i - \sum_{j=i}^{n} (P_{xji}.X_{ji}) - TFC$$

Where:

Π_1 = profit per hectare from ith output,
P_{yi} = per unit price of ith output,
Y_i = total quantity per hectare of ith output,
P_{bi} = per unit price of ith by-product,
B_i = total quantity per hectare of ith by-product,
P_{xji} = per unit price of jth input used in producing ith output,
X_{ji} = total quantity of jth input used for the production of per hectare ith output,
TFC = total fixed costs involved in producing per hectare ith output,
i = the number of individual crops produced by the farmers,
j = the number of individual inputs used for producing the relevant product
n = 1, 2, 3, ... n.

For the lack of exact information, the value of by-product and the fixed cost of land are omitted in the case of profitability analysis. T-tests are performed to examine significance of mean difference whenever necessary. To test mean difference of profit the t statistic as shown below was used

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

With, $$v = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$$

degree of freedom.

Where, X_1, X_2 are the sample mean profit, S_1 and S_2 are corresponding standard deviations and n_1 and n_2 are sample size. By applying the above formula, the calculated values were compared with tabulated values to test whether the results were statistically significant or not.

Results and Discussion

Input Productivity

The input productivity for important crops grown on different categories of farms was examined with the help of production function analysis. Linear regression equation was estimated through ordinary least squares method, where the human labour, fertilizers, seed, insecticides, irrigation and land cultivation were regressed upon yield. Production functions on per hectare basis were estimated for Boro and Aman Paddy.

The estimated regression coefficients are presented in Table 1. It may be observed from table that the inputs, namely human labour, fertilizers, seed, insecticides,

Table 1 : Production Functions for Selected Corps on Power tiller, Animal Operated Farms and Pooled Farms, Sylhet Region, 2008

Category	Mechanical Power		Animal Power		Pooled	
Variables	Boro	Aman	Boro	Aman	Boro	Aman
Constant in log	2.0756	1.89	1.92	1.49	2.66	1.82
Human labour	0.104*** (0.055)	0.082** (0.032)	-0.044 (0.046)	0.010 (0.013)	0.052 (0.040)	0.023*** (0.013)
Fertilizers	0.060** (0.025)	0.168* (0.036)	0.078*** (0.041)	0.126** (0.050)	0.061* (0.020)	0.105* (0.030)
Seed	0.181* (0.053)	0.033 (0.031)	0.146** (0.061)	-0.003 (0.013)	0.206* (0.038)	0.015 (0.012)
Insecticides	0.033 (0.034)	0.007 (0.015)	0.043 (0.054)	0.008 (0.007)	0.042 (0.028)	0.023 (0.006)
Irrigation	0.024 (0.025)	-0.059 (0.009)	0.052 (0.098)	0.011 (0.072)	0.005 (0.021)	-0.036 (0.052)
Tillage	0.021 (0.033)	0.282* (0.053)	0.277** (0.110)	0.692* (0.060)	0.045 (0.029)	0.504* (0.046)
R^2	0.313	0.91	0.86	0.95	0.45	0.89
F Value	5.40	68.13	25.93	57.69	14.32	94.8
Returns to scale	0.423	0.513	0.552	0.844	0.41	0.634

Source: *Author's calculation*
*1 % Significance,** 5% Significance, *** 10% Significance
Figure in the parenthesis show standard error of the respective co-efficient.

irrigation and land cultivation were jointly responsible for explaining about 31 to 95 percent variations in the yield of major crops between the animal and power tiller operated farms. In the case of log linear Cobb-Douglas type of production function, the estimated parameters gave the production elasticity of factors included in the model. The elasticity of an input indicates the percent increase / decrease in the quantity of that input for any specified level of use of other inputs.

The coefficients of partial elasticity of production of all the six inputs (human labour, fertilizers, seed, insecticides, irrigation and land cultivation) were less than unity with positive signs at all the levels of mechanization implying diminishing marginal productivity of factor inputs. In other words, by holding the other inputs constant at their geometric mean levels, and increasing any of them, the yield would increase at a diminishing rate. The coefficients of partial elasticity of production of inputs were greater or less than unity with negative sign indicates that any increase in these inputs will have negative impacts on total production of crops. The intercepts of the estimated equations were positive in the case of Boro and Aman Paddy on Power tiller and Animal operated farms.

Human Labour

It can be seen from Table 1 that the human labour use in the crop production process was statistically significant for the crops of Boro and Aman Paddy under Mechanized farm. The effect was significant at 10% and 5% level, respectively for Boro and Aman paddy on power tiller operated farms. The elasticity coefficients of human labour for Aman and Boro paddy indicate that the higher human labour use would surely increase the yields and returns of Boro and Aman paddy of all categories of farms, especially power tiller operated farm.

The insignificant effects of human labour use on output were found to be in the case of Aman paddy of animal power operated farms. The regression coefficient -0.044 indicates that for a unit increase of human labour in Boro paddy under animal operated farm the output will result in a 0.044 unit decrease. In the case of pooled farm the effect was statistically significant at 10% level for Aman paddy and the effect was statistically insignificant for Boro paddy under pooled farms. The comparison of elasticity coefficients of human labour use among the different categories of farms for different crops shows that for the crop of Boro, the elasticity coefficient was maximum for power tiller operated farms. This indicates that the increase of the output will be maximized of the power tiller operated farms by increasing one unit of human labour use on such farms compared to other categories of farms.

Fertilizers

The production elasticity coefficients of fertilizers were statistically significant at 1% level in the case of Aman on power tiller operated farms. The coefficients were statistically significant at 5% level for Boro and Aman paddy on power tiller and animal operated farms, respectively. The coefficients were significant at 10% level for Boro paddy on animal operated farms. In the case of pooled farm the production elasticity coefficients were statistically significant at 1% level for both Boro and Aman paddy.

The comparison of elasticity coefficients indicates that in the case of both animal operated farms and power tiller operated farms, it was highest in Aman paddy production. Thus, the use of fertilizers would significantly increase the output of the Aman crop among various categories of farms.

Seeds

It can be seen from Table 1, that the seed used in the production process was statistically significant for the Boro Paddy under power tiller operated and pooled farms. The effect was statistically significant at 1% level for Boro Paddy on power tiller operated and pooled farms and 5% level for Boro Paddy on animal operated farms. The insignificant effects of seed use on output were found to be in the case of Aman Paddy on the power tiller operated farms. The production elasticity coefficient of -0.003 indicates that for a unit increase of the seed cost will result in a 0.003 unit decrease in the output of Aman paddy under animal operated farm. In pooled farm, 1% level of significance was found for Boro Paddy where as the effect was insignificant in the case of Aman paddy.

The comparison of elasticity coefficients of seed use among the different categories of farms for different crops showed that for the Boro crops, the elasticity coefficient was the maximum for power tiller operated farms. This indicates that the increase in the output would be maximized in the power tiller operated farms by the one unit increase seed use on such farms, than on the other category farms.

Insecticides and Irrigation

The production elasticity coefficient of insecticides and irrigation was statistically insignificant for Boro paddy on power tiller and animal operated farms. In the pooled farm the production elasticity coefficients of insecticides were statistically insignificant for both Boro and Aman paddy where as the irrigation has negative impact on production of Aman under pooled farm.

Power tiller or Animal Power

The production elasticity coefficients of power tiller and animal power were statistically significant at 1% level in the case of Aman Paddy. The coefficient was statistically significant at 5% level for Boro Paddy on animal operated farms. The insignificant effects of power tiller use on output were found to be in the case of Boro Paddy on the power tiller operated farms. The production elasticity coefficient of Aman Paddy was statistically significant at 1% level under pooled farm where the coefficient is insignificant for Boro paddy in the case of pooled farm.

Returns to Scale

The returns to scale explain the behavior of change of yield when all inputs are changed simultaneously in the same proportion. This is indicated by the sum of individual elasticity coefficients of factors include in the Cobb-Douglas production function. Increasing, constant or decreasing returns to scale were said to exist, accordingly as the sum of coefficients was greater than, equal to, or less than unity. Based on this criterion, the sum of elasticity of the factors (Table 1) showed that there is no increasing return to scale in the case of Boro and Aman on power tiller, animal operated and pooled farms. Irrespective of the crops, returns to scale of all the crops was less than unity indicating the decreasing returns. Put in another way, unit increase of these factors of production would result in diminishing returns in all these cases.

Profitability of Rice Production

In order to calculate profits, comparative profitability of different cropping patterns, costs and returns of Aus, Aman and Boro paddy have been considered. To calculate profit we have considered total return from output and by-products minus total variable cost and fixed costs involved in producing per hectare output. In the survey, farmers are unable to give exact price of by-products because they use the by-products for feeding animals. So in this study, the return from by-products is omitted.

For the lack of perfect information about rental and mortgage rate of land, the total fixed cost is also excluded from the model. In this model we have only considered the variable cost, including labour, fertilizer, seed, insecticides, irrigation and power tiller or animal cost. The production cost per hectare of Boro paddy under power tiller is Tk. 31165 where the market value is Tk. 89715 and the profit is Tk. 5854. The gross value, total variable cost and profit of Boro paddy under animal operated farm are almost same compared to the Boro paddy under power tiller operated farm (Table 2).

In the case of Aman Paddy under power tiller operated farm, the gross return is Tk. 90765per hectare where the total cost is Tk. 33004 and the profit is Tk. 57761. Under animal operated farm, the gross value (per hectare) of Aman paddy is Tk. 85039, where the total variable cost is Tk. 26918 and the profit of the production of Aman is Tk. 58120 per hectare. There is very little irrigation cost in the cultivation of Aman but the seed cost is high compared to the Aman Paddy under

Table 2 : Profitability of Individual Farmers (in Taka)

Farm Category	Gross value (ha)	Labou r cost	Fer. cost	Seed cost	Ins. cost	Irr. cost	Tillag e cost	Total cost (ha)	Profit (ha)
Boro-PT operated Farm	89715	14921	2197	1876	749	6632	4787	31165	58549
Boro-animal operated farm	87598	14945	1595	1665	822	4491	4565	28086	59512
Aman-PT operated farm	90765	16369	1884	1742	761	7606	4639	33004	57761
Aman-animal operated farm	85039	15103	1377.86	2339	1457	6233	4073	26918	58120
Boro-Pooled	89113	14928	2026.28	1816	770	6023	4724	30289	58823
Aman Pooled	88831	15941	1713	1944	996	6157	4448	324737	56358
Aus-Pooled farm	92124	13064	2741	3305	662		3293	23067	69057

Source: *Author's Own Calculation*

power tiller operated farm. The total input cost (Tk. 23067) of the production of Aus is low compared to the other crops and the net return (Tk.69057) is higher than Boro and Aman because there is no irrigation cost.

The profit variations with variety were found to be significant (through t-test) for all crops (Table 3). From table 3 it is seen that the observed t' value is greater than the tabulated t value at 1 percent level of significance for all the crops. In the case of Boro paddy under animal and power tiller operated farms, the profit under animal operated farms is greater than power tiller operated farm on the basis of the evidence available. For Aman paddy, the profit under power tiller operated farms is higher than animal operated farms.

Major Problems in Input Productivity and Policy Suggestions to Overcome the Crisis

Our farmers are very poor and illiterate. They are not conscious about modern technology. 60.83% of farmers cannot use modern technology because of money problem. 16.67% of farmers cannot buy power tiller, power pump, hybrid seeds as the market price is very high. The supply of hybrid seed is not available in the

Table 3 : Profit Variation Due to Varietal Differences of Different crops

Crops/ Variety	Power tiller Profit (tk/ha)	Animal Power	Differences in profit (in Tk.)	T-values	Degrees of freedom	Remarks
Boro Paddy	58549.96	59512.73	962.77	4.54	48	*
Aman Paddy	57761.24	53607.70	4153.54	2.98	25	*

Source: *Author's Own calculation*. Note: * Means significant at 1 percent level

cropping season. Farmers collected hybrid seeds from thana agriculture office, which is at a distance of 2 to 3 kilometers from some villages. So, in most of the cases farmers are unable to collect hybrid seeds from the agriculture office.

In the production of rice, the major problem is inadequate supply of inputs. In the cropping season farmers do not get enough urea fertilizer. Sometimes the farmers buy fertilizer from black markets at a high price and this increases their production cost. If farmers do not use fertilizer in time, the plants cannot grow properly and the rate of production decreases. From the past decade government gave license to some dealers to sell fertilizers in a market price where the price was fixed by government. But in most of the cases farmers did not get fertilizers from the dealers at fair price. The government agents sell the fertilizers in the black market or give facility to their relatives or well wishers. In the present time another major problem in mechanization in our country is high market price of fuel. Diesel is needed to run the power tiller and power pump. The price of diesel in the local as well as international market has increased, so, the cost of production also increases. Mechanization has also created unemployment problem. If the modern technology is adopted, less labour is needed for ploughing, irrigation, weeding and threshing.

The Ministry has undertaken a number of policy reforms in recent years for which it has received considerable recognition from development partner. Agro sector by this time has already achieved the cherished long term goal of self sufficiency in the production of rice. The major success of the Ministry is its unquestioned success in spurring the growth of crop agriculture while saving considerable amount of local currency through eliminating the subsidies on fertilizers and also allowing private trade in fertilizers, minor irrigation equipment and seeds. As a development strategy, the present government has accorded highest priority to the agriculture sector. The commitments in this respect are reflected in the National Agriculture Policy that includes:

- Timely supply of agricultural inputs at affordable prices,
- Appropriate action plan for agricultural credit and marketing of agricultural products,
- Set up deep tubewell in the study area to give irrigation facility to the farmers.
- Government should take steps to improve the seed quality or supply hybrid seed at reasonable price,
- Import if agro-machines, including power tiller, was liberalized – resulting in the positive effect on import of power tiller.
- Enhanced rate of private sector-participation in supply of agro-machinery,
- Greater coordination between the government, NGOS and private sector,

Bangladesh agriculture is now in the process of transformation from subsistence farming into commercial farming. Bangladesh has already entered into the European Market for export of vegetables and other high value crops. The process opens a vista to private sector investment in the areas of production of high value crops, production of seeds, especially hybrid seeds, chemical and blended fertilizers, agro-processing enterprises, etc. The policy reforms that have taken place offer greater scope and opportunities for private sector participation and have created a suitable environment for promoting agro-business and investment.

Conclusions

There is an ample scope to increase the net returns to fixed factors among all the categories in the study district, especially on power tiller operated and animal plus power tiller operated farm where the impact of mechanization on net returns was highly positive, indicating better profitability conditions existing in such farms. Apart from this, the farmers of the study area need to be provided with timely and adequate quantum of credit, especially for the purchase of small machinery and small farm equipments. Hence, better credit planning and disbursal is required from the concerned government agencies.

References

1. Ahmed, R., Haggblade, S. and Chowdhury, T. (2000). Out of the Shadow of Famine; Evolving Food Markets and Food Policy in Bangladesh. Baltimore, Md. USA and London; The Johns Hopkins University Press.
2. BAU. (2001). Socio-economic impact of mechanized cultivation on livelihoods of rural labourers in Bangladesh. A PRA report of four selected villages in Bangladesh, PEFPI project, Dept. of Farm Power and Machinery, BAU, Mymensingh.
3. Bangladesh Agricultural Census, (2008). Ministry of Agriculture, Government of the People's Republic of Bangladesh.
4. BBS, (2006). Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning and Development, People's Republic of Bangladesh.
5. BBS, (2013). Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning and Development, People's Republic of Bangladesh.
6. Bangladesh Economics Review (2013). Planning Division, Ministry of Planning, Government of the People's Republic of Bangladesh.
7. Duft, B. (1986). Some consequences of agricultural mechanization in Philippines, Thailand and Indonesia. In. Small Farm Equipment for Developing Countries. Proceedings of the international conference on small farm equipment for developing countries.
8. Dillon, J. and Hardaker, B. (1980). Farm management research for small farmer development, FAO (n. 4 1), Rome 1980.
9. Hossain, M., BOSE, M. L. and Bazlul A. A.MUSTAFI, B.A.A. (2006). Adoption and Productivity Impact of Modern Rice Varieties in Bangladesh. The Developing Economies, XLIV-2 (June 2006): 149–66.
10. Household Income and Expenditure Survey, (2012). Bangladesh Bureau of Statistics, Ministry of Planning and Development, People's Republic of Bangladesh.
11. Labour Force Survey, (2009). Bangladesh Bureau of Statistics, Ministry of Planning and Development, People's Republic of Bangladesh.
12. Mahendran K. (1995). An Economic Study of Farm Mechanization in South Arcot District of Tamil Nadu. Indian agricultural Research Institute, New Delhi.
13. Majumder, M.K., Mozumder, L. and Roy, P.C. (2009). Productivity and Resource Use Efficiency of Boro Rice Production. J. Bangladesh Agril. Univ. 7(2): 247–252, 2009 ISSN 1810-3030.

14. Miah, M. A. M. (2002). Socio-economic Impact of Mechanization on livelihoods of Rural Labourer in Bangladesh; Some Cases Study. Workshop Proceedings on Socio-Economic Impact of Mechanization on livelihoods of Rural Labourer in Bangladesh, IDB Bhoban, Sher-e-Bangla Nagar. Dhaka, Sept.2002.

15. Pandey, M. M. (2004). Present Status and Future Requirement of Farm Equipment for Crop Production. Project Coordinator, AICRP on FIM, Central Institute of Agricultural Engineering, Bhopal.

16. Rahman, S. (2003). Profit Efficiency among Bangladeshi Rice Farmers. Proceedings of the 25th International Conference of Agricultural Economists, ISBN Number: 0-958-46098-1, (IAAE) 16 – 22 August 2003, Durban, South Africa.

17. Talukder, M.S.U., Adham, A.K.M., and Ahmed, M. (2004). Maximizing The Productivity of Shallow Tubewell By Upgrading The Management Practices, *Bangladesh J. Agril. Sci*. 31(2): 175-180, July, 2004.

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 279-284
Bangladesh Economic Association
(ISSN 2227-3182)

Impact of Modern Technology on Food Grain Production in Bangladesh

Md. Nazrul Islam*

Introduction

The economy of Bangladesh is basically agrarian. At present the agricultural sector is the major sector in terms of livelihood and employment with half of the labour force engaged in it (GOB, 2012, p. 1). This sector is the main source of food and nutrition and dominated by crop agriculture.^Within the crop sub-sector rice crop dominates in terms of both cropped area (74 percent) and production (54 percent) in 1996-97 (GOB, 1998). Bangladesh is a densely populated country. High pressure of population on limited land is a major constraint to promote agricultural development. Many people live on the verge of starvation or suffer from food deficiency. Every year a lot of money is spent for importing food grains due to the increasing growth of population. The only way to lift the economy from the existing stage is to produce food-grains to self-sufficiency level. It may be noted that agricultural development would not be achieved without the proper application of agricultural inputs like HYV of seeds, fertilizers, irrigation water either individually or in suitable combination. The suitable combination of HYV of seeds, fertilizers, pesticides and irrigation water can increase agricultural output considerably. In a land scarce economy like Bangladesh the adoption of modern technology has opened up opportunities for increasing food production and employment. The last few decades have witnessed major transformation of agriculture, including changes in technology, resource base, and structure and production process. Now agricultural sector is much more diversified. Since no detailed research has yet been conducted on this issue. This paper analyses the impact of modern technology on food grain production in Bangladesh.

* Professor, Department of Economics, Jatiya Kabi Kazi Nazrul Islam University, Trishal, Mymensingh.

Methodology and Importance of the Study

The study is based on secondary data, collected from different published and unpublished documents. The results of the study may be of great use to policy makers regarding the use of modern technology in agricultural production. The farmer would derive similar benefit from the study. The study will also stimulate interest among researchers to undertake further studies on the issue. The study has also great academic importance to teachers and students of Economics.

Impact of Modern Technology

The crop sector provides staple food such as rice, wheat, pulse, oil etc. Since independence of Bangladesh rice production has increased from 11 million tonnes to about 32 million tonnes (GOB, 2012). Growth of rice production was about 2.8% per year in'the 1980? and 3.5% per year since 1990?. Most of the growth in rice production has occurred since late 980? through adoption of improved varieties of rice supported by rapid expansion of irrigation water. In recent years some policy reforms have been implemented by the government, which include privatization of input distribution, input and food subsidy and import liberalization. The major factors behind food-grain production are the development and diffusion of modern varieties of seeds and rapid expansion of ground water irrigation.

Modern technology in the form of seed, fertilizer and irrigation arrived in Bangladesh as early as 1960?, but its popularity and acceptance grew in the post liberation period. In 1965 - 66, the area irrigated by modern methods was 2,00,000 acres, which increased to 26,38,000 acres in 1979 - 80 (M. Hossain, 1989, p. 27). In 2009 - 10 about 56.9 lakh hectares of land was irrigated. In 2003 - 04 the irrigated area was 48.33 lakh hectares.

Available data indicate that the area under deep tube well irrigation was 6,60,260 hectares and the area under shallow tube well irrigation was 29,31,181 hectares in 2009-2010. (BER, 2011, P. 94).

The farmers of Bangladesh have been using modern irrigation technology because it has the inherent advantage of being affordable. A steady rise of irrigation technology has been influencing the use of HYV of seeds, chemical fertilizers and pesticides. The use of modern variety of seeds was negligible up to the end of 1960? but increased gradually in the 1970?. Total area under modern variety of seeds was nearly 3,78,000 acres in 1968 - 69 but it stood at about 59,53,000 acres in 1979 - 80 (M. Hossain, 1989, p. 25).

In the 2009 - 10 BADC produced 129083 metric tonnes of seeds (B.B.?, 2011).'By the end of 1960? fertilizer consumption had increased to over 4 kilogram of nutrients per acre (M. Hossain, 1989, p. 25). In FY 2009 - 10 the total quantity of fertilizer consumption was 30.05 lakh metric tonnes, of which the consumption of urea was the highest - 24.09 lakh metric tonnes (BFR, 2011).

In FY 2009 - 10 nearly 44496 metric tonnes of boro seeds (HYV : 44427 metric tonnes and hybrid : 69 metric tonnes) were supplied to the farmers, which were 7922 metric tonnes larger than the supply in the previous year. However, this distribution is 50 percent of the national demand.

In recent years the agricultural sector is much more diversified than it was three decades go. The last three decades have witnessed vital changes in this sector, including changes in its resource base, technology, structure and production process, which contributed significantly to raising agricultural production. The rapid growth of modern inputs have had a positive impact on food-grain production. Available data indicate that, since independence, rice production has increased from 11 million tonnes to 32 million tonnes (GOB, 2012, p. 5). Most of the growth has occurred since late 1980 through the adoption of modern varieties of rice supported by rapid expansion of irrigation water. During the last two decades more than 80 percent of the increase in rice production has come from the expansion of irrigated boro rice, with reallocation of land from low yielding rain-fed Aus rice. Now, three-fourths of rice area is cropped with modern varieties of rice (GOB, 2012).

Table I presents the food-grains production.

Table I: Food-grain Production (in lakh metric ton)

Food grains	2002-03	2008-09	2009-10
Aus	18.51	18.95	17.09
Aman	111.15	116.13	133.07
Boro	122.22	178.09	183.41
Total rice	251.88	313.17	322.57
Wheat	15.07	8.44	9.69
Maize	1.75	7.30	8.87
Total	268.70	328.96	341.13

Source : *Bangladesh Economic Review 2010, GOB, 2011, Dhaka, P. 90*

Table I shows that total food-grains production in FY 2009 - 10 was 341.13 lakh metric tonnes, of which Aus accounted for 17.09 lakh metric tonnes, Aman 122.07 lakh metric tonnes, and Boro 183.41 lakh metric tonnes. The production of wheat in FY 2009 - 10 stood at about 9.69 lakh metric tonnes between 2002-2003 and 2009-2010, food-grains production increased by 27 percent mainly due to various measures taken by government to provide agro-inputs assistance, which include reduction of price of non-urea chemical fertilizers and cash incentives for diesel. Moreover, the introduction and adoption of non-urea fertilizer ensured balanced use of fertilizers by farmers, which contributed to the increase yield of Boro. During the last two decades, the Boro crop was the major rice crop in Bangladesh. “This indicates a structural shift in Bangladesh’? rice production from a largely weather influenced crop to an irrigated crop.” (Uttam Kumar Deb et. al, 2007, p. 666)

Growth in Area and Production of Food-grains

Available data indicate that HYV rice output and acreage have been changing over time. M. Hossain (1999, p. 42) observed’that HYV rice acreage had increased from 15% to 52% of the total acreage during the period between mid-seventies and mid-nineties, while, HYV rice output increased from 30%) to 70%) of total rice output during the same period. The increase in the area under rice was responsible for increased production of rice. Uttam Kumar Deb and others (2007) observed that area under rice increased at the rate of 0.7%) in the 2000? as against 0.6 percent in the 1990?, whereas it declined at the rate of 0.1%) in the 1980?. Wheat area declined at the rate of 7.2 percent in the 2000? compared to 1.2 percent increase in the 1980? and 4.3 percent increase in the 1990?. They further point out that the area under HYV Aus, HYV Aman and HYV Boro increased but the area under the local varieties declined in the 1990? and 2000?. This thing happened mainly due to the adoption of HYV by farmers through replacing local varieties. Production of food grain showed a higher rate of growth during 1980? to 2000?. Production of rice showed a larger rate of growth (3.7% annually) in the 2000? than 3.3 percent in the 1990? and 2.7 percent in the 1980?. Growth rate of Boro production was 8.2%), 7.0%) and 4.4 percent in the 1980?, 1990? and 2000? respectively. Growth rate of Aman production was 1.7%), 0.8%) and 3.6%) in the 1980?, 1990? and 2000?, respectively. Growth rate of Aus rice production in the 1980?, 1990?^ and 2000?. was 3.1%), 1.7% and 1.4 percent, respectively (ibid 2007, p. 674). Growth rate of total food grain production in the 1980?, 1990? and 2000? were 2.4%), 3.5%) and 2.9 %>, respectively.

Shahabuddin (2010) mentioned that the rate of growth in agricultural output increased by 2.7 percent during 1972 - 73 to 1992 - 93. Output grew during 1972 - 73 to 1985 - 86 by 3 percent. He also found that agricultural output grew at the rate of 1.6%) during 1990 - 95. Growth rate of output increased sharply by 4.7 percent during 1996 - 2000, but decelerated to 2.8 percent during the period 2001

- 08 (Shahabuddin 2010). It appears that total rice production increased substantially during the 1990? and the 2000?, and Bangladesh had achieved the highest level of food grain production in 2009-10.

The growth rate of output at 2.9 percent in the immediate past decade (2001-2010) is heralded as a success, made possible by the adoption of the new technology. The steady growth of new technology has thus had a positive impact on food grain production.

Conclusions

The agricultural sector is now much more diversified than a few decades ago. The last three decades have witnessed major changes in agriculture, including changes in technology. resource base and production process. During the last three decades Bangladesh have had a tremendous growth in agriculture. The rapid expansion of the new technology has had a positive impact on food grain production. Agricultural output grew by 4.7 percent during 1996 - 2000. The growth rate of agricultural output in 2001-10 was 2.9 percent. The significant improvement in agriculture can highly be attributed to a steady dissemination of the new technology over the last three decades. Policy suggestions that emerge from the paper are the following:

(1) Strengthening of agricultural extension and support services for promotion of agricultural activities.

(2) Interdisciplinary knowledge of economists, agriculturists and environmentalists should be incorporated in the modern farming and related research.

(3) Diversification of farming system should be encouraged in order to help improve economic condition of the farmers.

(4) In order to increase agricultural output and yield, an integrated land use policy is essential.

References

1. Government of Bangladesh (2012) : *The Sixth Five Year Plan*, Ministry of Planning, Dhaka.
2. Government of Bangladesh (2011) : *Bangladesh Economic Review 2010*, Ministry of Finance, Dhaka.
3. Government of Bangladesh (1999) : *Census of Agriculture Vol. 1*,Bangladesh Bureau of Statistics, Dhaka.
4. Government of Bangladesh (1998) : *The Fifth Five Year Plan 1997 - 2002*, Ministry of Planning, Dhaka. ‘
5. Government of Bangladesh : *Statistical Year Book of Bangladesh,* 1979, p. 228, Dhaka.
6. Hossain, M. (1989) : *Development Policies, Economic Reforms and the Rural Economy of Bangladesh*, Center for Policy Dialogue, Dhaka.
7. Hossain, M. (1989) ? *Green Revolution in Bangladesh, Impact on Growth and Distribution of Income*, University Press Limited, Dhaka.
8. Jansen, E.G (1997) : “Choice of Irrigation Technology in Bangladesh : Implications for Dependency Relationship between Rich and Poor Farmers”, DERAP working paper No. A 146, Bergen.
9. Shahabuddin, Quazi (February 24, 2010) : “Pushing Agriculture Forward”, The Daily Star, P. 22.
10. Uttam Kumar Deb et. al (2007) : “Food grain Production Situation in the 21st Century”, Arthonity Samittee, BEA, Dhaka.

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 285-303
Bangladesh Economic Association
(ISSN 2227-3182)

Farm and Non-Farm Employment of Rural Landless Households: Evidence from survey data

RANJIT KUMAR SARKAR*
M. A. SATTAR MANDAL**

Abstract *Farm and non-farm employment pattern of the rural landless households varies according to time and profession. In the farm sector, the flexibility is more than in non-farm sector. Non-farm workers' work availability per month was always more than farm workers'. Besides, farm employment was very much fluctuating, compared to non-farm employment. High peak and slack time exist in farm work. From the study it was found that farm employment increased during transplanting and harvesting of Aman and Boro season. Non-farm employment also increased during or after harvesting of Aman and Boro season. During peak farm season, the intensity of work for the non-farm earning members always remains higher than in off or slack season. This implies that there is a relationship between farm and non-farm employment. Among the rural non-farm profession, service workers remain engaged in work for more time, but their monthly income is not high enough compared to other non-farm profession because of low wage rate. Transport workers' daily income was two and a half times more than service workers' because of skill jobs. On an avegage***,** *farm and non-farm earning members' wage rate or return was Tk. 76 and Tk. 135 per day. Non-farm earning members wage rate was always higher than in farm workers. Again, the wage rate of the farm related non-farm households was less than inother non-farm households. Farm wage also varies with respect to peak and lean season. Non-farm wage followes the same pattern. Sales workers, service workers, production workers, transport workers and labourers' wage rate was Tk. 159, 71, 151, 171 and 19 per day, respectively. Rural non-farm employment*

* BCS (Economic) Cadre Officer. Currently Senior Assistant Chief, Local Government Division, Ministry of Local Government, Rural Development and Cooperatives, Bangladesh Secretariat, Dhaka. This paper is derived from the author's PhD dissertation supervised by the second author.

** Professor of Agricultural Economics and Former Vice Chanchelor, Bangladesh Agricultural University, Mymensingh.

can play an important role in increasing wage or return and income opportunities and thus in reducing hardship during lean season and poverty for all time. Rural non-farm employment also can develop intersectoral linkages. Promoting rural non-farm employment is, therefore, a necessary option through providing skill training to the farm workers in different trades and increasing provisions for electricity and communication facilities.

1. Introduction

Rural areas across most of the developing world face a formidable employment challenge. Even with migration to cities, rural populations continue to grow, sometimes very rapidly, as in Bangladesh and South Asia. Each year's addition to the rural labor force needs to find work in agriculture or in the rural non-farm sector, or to migrate to urban areas. In Bangladesh, despite an increasing trend of migration of the rural poor to the urban areas for work, a majority of them still remain in rural areas for livelihood.

About 80 percent of the population of Bangladesh live in the rural areas and are directly or indirectly dependent on agriculture. Agriculture has proved to be the prime mover of growth in the national economy. The amount of cultivable land for crop production is also gradually decreasing due to housing, construction works and other infrastructure development. Besides, the inequality in landholding is striking. Recent estimates show that nearly a half of the country's rural population are effectively landless owning at most 0.02 hectare of agricultural land (World Bank, 2002).

Since the early 1970s attention has been paid to the significance of the non-farm sector in the rural Indian economy (Lanjouw and Sharif, 2002). During the 1990s, the non-farm activities, assumed an increasingly important role in rural economic growth of Bangladesh. According to LFS data, the employment in agricultural sub-sector declined from 63 percent in 1995/96 to 52 percent in 2005/06. On the other hand, non-agricultural employment rose from 37 percent to 48 percent during the same period (BBS, 1996, 2008). Major occupation- wise employment data also shows the same trend. This indicates increasing work opportunities in the rural non-farm sector as a result of growth and diversity of agricultural enterprises.

Rural households with no cultivable land have to mainly depend on their income from farm or non-farm employment. Farm employment may be agricultural wage labour or farming. On the other hand, non-farm employment may be of different types. The landless households have no or little scope of earning from farming. A few households may be involved as share cropper but this source of income may not cover their year round food and non-food expenditure. Partly s/he has to depend on direct labour selling to either farm or non-farm sector. In a household there may be one or more earning members of whom one may be full time non-farm employee and others may be full time farm employee and vice versa.

Rural landless non-farm households who have no monthly basis employment in professional, managerial or technical job have to depend on employment on daily wage basis. These types of households have to meet their daily expenses from their daily income. Their daily income depends on daily employment availability either on farm or non-farm sector. Availability of farm wage employment does not remain the same in all the months as because of seasonal nature of the the farm production. On the other hand, non-farm employment availability also depends on seasonal factors. Rural landless household's employment availability also depends on the earning members of the households. Rural landless non-farm households are classified as pure landless non-farm households and mixed landless non-farm households on the basis of farm and non-farm earning members. If all the earning members of the households are non-farm employee then the households are termed as pure non-farm households. If any one of the earning members of the households is farm employee then the households are termed as mixed non-farm households. Landless non-farm households can also be classified as farm related and other non-farm households. Farm related non-farm households are those households that are engaged in farm related non-farm activities, like hen trade, rice processing and selling, blacksmith, hotel boy, rice haller owner, pita and bara maker and vegetable shopkeepers etc. Other non-farm households may have earning members not directly related to farm activities. Their profession includes carpenter, mason, tailor, home garments, rickshaw puller, van driver and grocery shopkeepers etc.

Employment availability of farm and non-farm workers and their wage rate vary over time. In rural areas farm workers' employment availability always depends on the production of farm products like crop, vegetable and other cereals. The farm workers are only skilled in farm activities and have no or limited skill in non-farm activites, and for this reason they have no or limited options to shift their profession during the lean season. Genderwise employment opportunity and wage rate also vary. Non-farm employment availability and wage rate also vary as per typology of non-farm employment and gender.

The livelihood of rural landless households depends on farm and non-farm wage, income or return. During lean season, having no or limited employment opportunity farm workers face employment and livelihood challenges. Having no employment opportunity in rural areas many want to migrate from rural to peri-urban and urban areas for their employment and livelihood. But the scope is very limited because of their illiteracy and poor income to bear transportation cost. As a result they always remain in poverty trap. To overcome the challenges, it is necessary to examine the scope of employment opportunity for the poor landless households on the basis of valid empirical data. The relevant research question includes: (i) What is the pattern of rural farm and non-farm employment for the rural landless households? (ii) What is the employment and wage variation between farm and non-farm workers? (iii) What policy measures will be helpful to promote rural non-farm employment for the rural landless households?

This paper seeks to find answers to these questions. Its specific objectives are:

(1) To measure and analyze the farm and non-farm employment pattern of the landless poor households;

(2) To find out sectorwise and typologywise employment and wage variation; and

(3) To recommend policies and strategies to promote rural non-farm employment in Bangladesh.

2. Methodology

2.1 Study Area Selection

The present study is based on primary data pertaining the year 2007-08 collected from three villages of Pirganj upazila under Thakurgaon district of Rajshahi division. The study area was selected following a stepwise approach giving emphasis on poverty incidence, intensity of farm related non-farm enterprises and communication and market linkages between growth centres, rural town and rural bazaar.

1. Three villages namely Daulatpur, North-Noyapara and Jabarhat were selected considering the following criteria:
2. Village Daulatpur was selected because it is located near urban area or pourashava bazar;
3. Village Jabarhat was selected because it is located near a growth centre or rural town; and Village North Noyapara was selected because it is located near a rural bazar.

2.2 Household Selection

To determine the pattern of rural farm and non-farm employmenrnt, households having no cultivable land were considered. Out of 280 selected households, 154 were landless households. Among landless households, 77 were non-farm landless households. From 77 non-farm landless households, 40 non-farm landless households were selected for the study. Landless non-farm households again were classified as farm related non-farm households and other non-farm households. Out of 40 non-farm landless households, 11 were farm related and 29 were non-farm landless households (Appendix Table-1).

2.3 Earning Member Selection

After household selection, earning members of the households were selected. Some of the households had only one earning member whose earning source was only non-farm employment. Some household may have more than one earning members of whom one was engaged in non-farm employment and others were engaged in farm employment. *In the study, 40 landless households had 70 earning members*. On an average the earning member size was 1.8. Out of 70 earning members, 54(77%) were involved in non-farm employment and 16(23%) were engaged in farm employment. Among the three villages, non-farm earning members were highest 87% in Jabarhat village and farm earning members were highest 32% in North-Noyapara village. Besides, out of 70 earning members, 48(69%) were male and 22 (31%) female. Of the total female earning members 50 percent were engaged in farm employment and 50 percent were involved in non-farm employment. The farm-nonfarm employment ratio for male earning member was 90 percent and 10 percent, respectively (Appendix Table-2).

Farm and non-farm earning members were also categorized according to types of employment. Earning members involved in farm employment was only agricultural labour but earning members involved in non-farm employment were sales workers, service workers, production workers, transport workers and labourers and helpers. Out of 54 non-farm household members 16(30%) were sales workers, 3(6%) were service workers, 18(33%) were production workers, 10(19%) were transport workers and 7(13%) were labourers and helpers (Appendix Table-3). Male female ratio for non-farm employment was 80 and 20 percent and the ratio for farm employment was 31: 69 percent.

Sales workers were involved in hen trade, rice processing and selling, rice hawler owner, middlemen of court and middlemen of rice and wheat business, ferry business (ice cream and zilapi), grocery shop, mobile grocery shop, hari, patil and deski trade, tea stall, vegetables shop, chira muri business, pita bara making and selling. Service workers were involved in hotel boy, maid servant, and poultry farm works. Production workers were involved in home garments, mixture machine operation, carpenter, tree cutting mistri, black smithy, jurir naru making, mason, and tailoring. Transport workers were involved in van driving, votvoti and nasimon driving, trolly driving, power tiller and tractor driving.

Farm and non-farm earning members were again categorized according to wage and self employment. Farm earning members sell their labour for wage and are termed as agril wage labour. Non-farm earning members selling their labour for wage are termed as non-agril wage labour. Non-farm earning members who did not sell their labour for wage but earned money working in their own enterprises were termed as self-employed. About *66 percent earning members were engaged in self-employment and 34 percent were under wage employment* (Appendix Table-4).

2.4 Analytical Techniques

Measurement of Employment

Farm and non-farm earning members were found out on the basis of time spent on farming or non-farming. Monthly employment can be measured in the following ways:

Farm Employment

$$\mathbf{FE} = \sum_{i=1}^{n} \mathbf{A_i}$$

Where

A = Number of working days of an economically active person in farm activities in a month

i = No. of working member(s)

FE = Farm Employment per month

Non - Farm Employment

$$\mathbf{NFE} = \sum_{i=1}^{n} \mathbf{B_i}$$

Where

B = Number of working days of an economically active person in non-farm activities in a month

i = No. of working member(s)

NFE= Non-Farm Employment per month

3. Results and Discussions

3.1 Month wise Employment Patterns of Farm and Non-Farm Earning Members

Non-farm households were categorized as farm related and other non-farm households. Earning members were engaged in farm and non-farm works. Month wise farm and non-farm employment pattern is given in T**able 1.**

Farm and non-farm earning members got employment on average of 15 days and 26 days per month. Farm workers get employment on an average 21 days in the month of July. After this, farm employment rate per month begins to decline and reach at 6, 5 and 5 days per month, respectively, in the month of August, September and October.

During the month of July farm employment availability rate per month was high because of increased labour demand for Aman transplanting activity. Another reason was that Aman transplanting is the more time consuming activity than

Table 1: Month wise Employment Patterns of Farm and Non-farm Earning Members

Month	**Month**	**Farm related HH**		**Other Non-farm HH**		**All HH**	
English	Bengali	Farm work	NF work	Farm work	NF work	Farm work	NF work
July	Mid-Ashar to Mid Srabon	22	25	21	28	21	27
August	Mid Srabon to Mid Bhadra	6	22	6	28	6	26
September	Mid Bhadra to Mid Aswin	5	21	5	28	5	26
October	Mid Aswin to Mid Kartik	4	21	5	27	5	26
November	Mid Kartik to Mid Agrahayan	21	24	21	26	21	26
December	Mid Agrahayan to Mid Poush	21	24	22	28	22	26
January	Mid Poush to Mid Magh	10	26	15	28	14	27
February	Mid Magh to Mid Falgun	22	22	25	26	25	25
March	Mid Falgun to Mid Chaitra	19	22	18	28	18	26
April	Mid Chaitra to Mid Baishakh	12	21	12	26	12	25
May	Mid Baishakh to Mid Jaistha	20	22	23	27	22	26
June	Mid Jaistha to Mid Ashar	19	22	14	27	15	26
All average		15	23	16	27	15	26

Source : *Field Survey, July-June 2007-2008* other farm activities and for this reason more employment is required. After transplanting, different intercultural operations like weeding and fertilizer and insecticide application are required which is less time consuming and for this reason farm employment rate decreased during the months of August, September and October. The farm labour demand again increased and reached 21 and 22 days per month on an average in the months of November and December. Aman harvesting starts in the month of November and ends in December. Aman harvesting is also a time consuming activity, and for this reason labour demand increased and employment availability reached the peak at 22 days in the month of December. In the month of January, labour demand again starts to decrease and stood at 14 days per month on an average. January month is the interim period of Aman harvesting and Boro transplanting.

Wheat broadcasting and vegetables cultivation activities are going on this time which is less time consuming and for this reason employment rate fell but remained in medium position. Boro transplanting starts in the month of February. As Boro transplanting is time consuming, the labour demand again increased in the month of February and employment availability stood at 25 days per month. Boro transplanting is a more laborious job than any other activities of crop production because other activities are interlinked with this activity. The interlinked activities include irrigation, manuring, fertilizing which are required just before transplantation. For this reason, Boro transplanting required more time and reached the peak period and employment availability rate stood highest at 25 days per month. After Boro transplantation, different intercultural operations of Boro rice are needed. The intercultural operations like fertilizer application, insecticide, pesticide and vitamin required less time and, for this reason, labour demand decreased and employment stands at 8 and 12 days per month in the month of March and April. Although another intercultural operation like irrigation needs more time, this activity is mainly done by the farmers themselves and, for this reason, opportunity of the landless wage labourer remained less. After April, Boro harvesting approached and labour demand started to increase in the month of May. Employment rate for Boro harvesting in the month of May stood at 22 days. Labour demand again decreased in the month of June and stood at 15 days. June month is the interim period of Boro harvesting and Aman transplanting. Boro rice processing activities are mainly done in this month and for this reason employment rate remained 15 days per month. On the other hand, month wise non-farm employment availability varies less than farm employment. The availability of non-farm employment varied from 25 to 27 days per month during the year. Non-farm earning members of the farm related households have less opportunity of employment than other non-farm households. On an average, farm related non-farm workers got employment 23 days per month and other non-farm workers got 27 days per month.

3.2 Season wise Employment Patterns of Farm and Non-Farm Earning Members

There are six partly overlapping seasons delineated in the Bangla calendar and two major rice-based seasons are prominent. The employment of households earning members was designed to reflect the pattern of rice-based seasonality. The survey was carried out in two rounds corresponding to the Aman and Boro cropping season. The first round of survey was conducted during the months of December and January, 2007 during the post harvest of Aman rice. The second round of survey was conducted during the months of June, 2008 to cover the post harvest season of Boro rice.

The strong seasonality of crop production in Bangladesh is well known to affect the timing of employment and income flows. Both Aman and Boro rice are the largest crop in Bangladesh Agriculture and hence their production and harvesting have the largest impact on agricultural employment and income. As the use of high yielding varieties and irrigation technologies has spread, Boro crop production has increased more in recent years. Again, Aman and Boro seasons have been categorized as peak and lean seasons. Within and in between Aman and Boro production, the total period of the year has been divided into four peak seasons and four lean seasons. The month of July can be termed as *Peak-1*, due to Aman transplanting. The month of August, September and October can be termed as *Lean-1,* falling between the Aman transplanting and harvesting period. The month of November and December can be termed as *Peak-2* for Aman harvesting. The month of January can be termed as *Lean-2*, falling in the Aman post harvest period. The month of February can be termed as *peak-3*, due to Boro transplanting. The month of March and April can be termed as *Lean-3*, which falls between the Boro transplanting and harvesting period. The month of May can be termed as *Peak-4* which falls into Boro harvesting period. The month of June can be termed as *Lean-4*, when Boro harvesting is generally complete.

Earning members were engaged in farm and non-farm works. Season wise farm and non-farm employment pattern is given in Table-2. Farm earning members got employment on an average 15 days per month for the year round. Considering season wise pattern, farm earning members got employment on an average 21 days in peak-1 season, the month of July because of Aman transplanting. After this period, lean-1 season starts in the month of August and continue upto October.

After Aman transplantation, few intercultural operations of Aman rice are needed. But the activities are less time consuming and for this reason labour demand drastically falls and stands at 5 days per month. During lean-1 season farm earning members of the landless non-farm household family had to remain unemployed because they had no expertise in non-farm activities. During this period, they had to remain idle and, having no money in hand, they needed to borrow money from *Mohajon* or Banks or NGOs. Besides, they had to sell their labour in advance.

During Aman harvesting, they sold their labour but did not get any money because they needed to repay their advance. They also had to repay their credit installment during the period of Aman harvesting. Another striking message here is that the main festival like Durga puja and Eid-ul-Fitr is held during lean-1 season i.e within August to October. The poor landless needed cloth and they had to buy it on credit. They had also to repay it from the earning of selling wage labour during Aman harvesting. Actually the poor landless did not get any benefit from selling labour during the harvesting time of Aman. The non-farm wage labour or employment during this period was 26 days per month, which was equal to average non-farm employment availability. This indicates that although farm labour demand decreases in the lean-1 season on an average, non-farm employment demand remains high. After this, Aman harvesting approaches and employment demand starts to increase. The reasons behind is Aman harvesting is more time consuming and requires employment 22 days per month in peak-2, the month of November and December. After Aman harvesting employment demand starts to decline. The reasons behind is that this is the time between Aman harvesting and Boro transplanting and requires intercultural operations which is less time consuming and requires employment for 14 days per month in lean-2, the month of January. Peak-3 season starts in February and it is the time of Boro transplanting. During this time employment demand again starts to increase and reach at 23 days per month. Farm employment availability was highest during this peak-3 because of interlinked activities like irrigation and fertilizer application. After Boro transplanting, different intercultural operations like weeding, fertilizer, insecticide application are available and require less time to complete the activities. For this reason, labour demand again decreaes in lean season-3 and stands on an average at 15 days in the month of March and April. The month of May is peak-4 season. The month is the Boro harvesting time and the poor farmers are engaged in Boro harvesting. They get employment on an average 22 days per month. After harvesting, employment demand again decreases in lean-4, the month of June, and stands at 15 days.

3.3 Relation between Farm and Non-Farm Employment

There is a relation between farm and non-farm employment. From Table-2 it is found that farm employment rises during transplanting and harvesting of Aman and Boro. Non-farm employment and income also rises just before, during or just after harvesting of Aman and Boro. The researchers interviewed 32 non-farm earning members questioning in which time their employment and income actually increase. They replied that their employment actually increases during or after harvesting of Aman and Boro rice. Besides, their employment also increases during and after other crop harvesting.

Table 2: Season wise Employment Patterns of Farm and Non-Farm Earning Members

(Days per season)

	Month	Month	Farm related NFHH		Other NF HH		All HH	
Season	**English**	**Bengali**	**Farm work**	**NF work**	**Farm work**	**NF work**	**Farm work**	**NF work**
Peak-1(Aman transplanting)	July	Mid-Ashar to Mid Srabon	22	25	21	28	21	27
Lean-1	August	Mid Srabon to Mid Bhadra	5	22	5	28	5	26
	Septem ber	Mid Bhadra to Mid Aswin						
	October	Mid Aswin to Mid Kartik						
Peak-2	Novem ber	Mid Kartik to Mid Agrahayan	21	24	22	27	22	26
Aman harvesting	Decem ber	Mid Agrahayan to Mid Poush						
Lean-2	January	Mid Poush to Mid Magh	10	26	15	28	14	27
Peak-3(Boro transplanting)	February	Mid Magh to Mid Falgun	22	22	24	26	23	25
Lean-3	March	Mid Falgun to Mid Chaitra	15	22	15	27	15	25
	April	Mid Chaitra to Mid Baishakh						
Peak-4(Boro harvesting)	May	Mid Baishakh to Mid Jaista	20	22	23	27	22	26
Lean-4	June	Mid Jaista to Mid Ashar	19	22	14	27	15	26
	All av.		15	23	15	27	15	26

3.4 Month and Typology wise *Non-Farm Employment Wor*kers Employment Patterns

Non-farm employment workers were (1) Professional, technical workers (2) Administrative and managerial workers, (3) Clerical workers (4) Peon related workers (5) Sales workers (6) Service workers (7) Production workers (8) Transport workers and (9) Laborers and helpers.

Month/season wise non-farm employment pattern is given in Table-3. The non-farm employment workers get employment opportunity on an average 26 days per month. They get employment year round. Sales workers, service workers, production workers, transport workers and labourers get employment 25, 30, 26, 28 and 24 days per month, respectively.

3.5 Wage Rate Pattern of Farm and Non-farm Earning Members

Month wise farm and non-farm wage rate pattern is given in **Table -4.** On an avegage**,** farm earning members' wage rate was 76 per day. But wge rate pattern was flexible. For example, farm earning members' wage rate was 78 Tk. per day

Table 3: Typology wise Non-Farm Workers Employment Patterns

English month	Bengali month	Sales workers	Service worker	Production worker	Transport workers	Labourer and Helpers	NF-Total
July	Mid-Ashar to Mid Srabon	26	30	27	29	25	27
August	Mid Srabon to Mid Bhadra	26	31	26	29	23	26
September	Mid Bhadra to Mid Aswin	25	30	26	28	23	26
October	Mid Aswin to Mid Kartik	25	30	25	28	23	26
November	Mid Kartik to Mid Agrahayan	26	30	25	28	22	26
December	Mid Agrahayan to Mid Poush	27	31	26	30	24	27
January	Mid Poush to Mid Magh	27	27	27	28	25	27
February	Mid Magh to Mid Falgun	24	29	24	26	23	25
March	Mid Falgun to Mid Chaitra	22	30	24	29	24	26
April	Mid Chaitra to Mid Baishakh	24	29	24	26	24	25
May	Mid Baishakh to Mid Jaista	26	30	27	26	25	26
June	Mid Jaishta to Mid Ashar	25	29	27	27	23	26
All average		25	30	26	28	24	26

in the month of July and then fell to 77, 65 and 65 Tk. per day, respectively, in the month of August, September and October and again reached 82 Tk. per day in the months November and December. Then again wage rate falls and stands at 68

Tk. per day in the month of January and again increases in the month of February and stands at 78 Tk. per day. Wage rate decreases and stands at 75 in the month of March and April and again increases in the month of May and stands at 88 Tk. per day and again decreases in the month of June and stands at 86 Tk. per day. Wage rate was high in different peaks and less in the lean periods.

Month wise per day wage rate of non-farm workers varies less than that of farm workers. The wage rate of non-farm workers ranges from Tk. 116 to 163 per day during the year. Non-farm earning members of the farm related households' wage rate is less than other non-farm households.

3.6 Month wise Wage Rate Variation of Non-Farm Employment Workers

Month wise wage rate pattern and variation of non-farm employment workers is given in Table-3.5 The non-farm employment workers' wage rate on an average was Tk. 135 per day. They get employment year round. Non-farm earning members' wage rate increased during peak seasons and decreased in the lean periods. Their wage rate increased mainly just after harvesting of Aman and Boro

Table 4: Month wise Wage Rate Patterns for Farm and Non-Farm Employment Workers

Month	Month	Farm related HH		Other Non-farm HH		All HH	
English	Bengali	Farm work	NF work	Farm work	NF work	Farm work	NF work
July	Mid-Ashar to Mid Srabon	83	103	77	154	78	139
August	Mid Srabon to Mid Bhadra	80	92	76	132	77	120
September	Mid Bhadra to Mid Aswin	47	90	69	128	65	116
October	Mid Aswin to Mid Kartik	47	88	69	131	65	118
November	Mid Kartik to Mid Agrahayan	87	114	80	149	82	139
December	Mid Agrahayan to Mid Poush	87	135	81	170	82	159
January	Mid Poush to Mid Magh	47	122	72	143	68	136
February	Mid Magh to Mid Falgun	60	112	82	129	78	124
March	Mid Falgun to Mid Chaitra	53	107	80	129	75	122
April	Mid Chaitra to Mid Baishakh	85	111	73	147	75	136
May	Mid Baishakh to Mid Jaista	92	121	87	162	88	150
June	Mid Jaistha to Mid Ashar	94	117	84	182	86	163
All average		72	109	78	146	76	135

Source : *Field Survey, July-June 2007-2008* paddy i.e in the month of December and June. Sales workers, service workers, production workers, transport workers and labourers' wage rate was Tk. 159, 71, 151, 171 and 19 per day, respectively.

4. Conclusion

Earning members of rural landless households were engaged in farm and non-farm works. Non-farm workers' work availability per month was always more than farm workers'. Farm earning members got employment on an average for 15 days per month whereas non-farm earning members got on an average 26 days per month. Besides, farm employment was very much fluctuating, compared to non-farm employment. High peak and slack time exist in farm work. There are 4 peak and 4 slack seasons. Among the slacks, slack-1, the month of August to October is the most vulnerable time for the landless farm earning members. Becasuse, during this period they get minimum employment on an average 5 days per

Table 5: Wage Rate Patterns and Variations of Non-Farm Employment Workers

English month	Bengali month	Sales workers	Service worker	Production worker	Transport workers	Labourer and Helpers	NF-Total
July	Mid-Ashar to Mid Srabon	152	67	152	203	16	139
August	Mid Srabon to Mid Bhadra	139	67	133	154	21	120
eptember	Mid Bhadra to Mid Aswin	140	67	130	136	21	116
October	Mid Aswin to Mid Kartik	143	67	134	136	16	118
November	Mid Kartik to Mid Agrahayan	167	67	152	179	16	139
December	Mid Agrahayan to Mid Poush	182	90	172	219	19	159
January	Mid Poush to Mid Magh	164	70	156	160	18	136
February	Mid Magh to Mid Falgun	147	70	137	154	20	124
March	Mid Falgun to Mid Chaitra	138	70	138	155	21	122
April	Mid Chaitra to Mid Baishakh	158	70	151	176	22	136
May	Mid Baishakh to Mid Jaista	173	73	174	183	19	150
June	Mid Jaista to Mid Ashar	201	73	177	201	20	163
All		159	71	151	171	19	135

month. During lean-1, although farm labour demand decreases, non-farm employment demand remains high. The implication of this is that if the farm labour would be able to shift their expertise from farm to non-farm activities they would be able to have more employment and get relief from miseries.

During the peak periods farm employment demand reached near about non-farm employment demand. The non-farm activities required more skill. The farm earning members would get employment during the lean season if they would become skilled on different non-farm activities. Earning members of the farm-related households have less opportunity than other non-farm households. On an average farm-related non-farm workers got employment 23 days per month and other non-farm workers got 27 days per month. From the study it was found that farm employment increased during transplanting and harvesting of Aman and Boro season. Non-farm employment also increased during or after harvesting of Aman and Boro season. During peak farm season, the intensity of work for the non-farm earning members always remains higher than in off or slack season. This implies that there is a relationship between farm and non-farm employment. The non-farm employment workers get employment opportunity on an average 26 days per month. They get employment year round. Sales workers, service workers, production workers, transport workers and labourers get employment 25, 30, 26, 28 and 24 days per month, respectively. Service workers' employment per month was highest compared to others.

On an avegage**,** farm earning members' wage rate was 76 per day. But wge rate pattern was flexible. The wage rate of non-farm workers ranges from Tk. 116 to 163 per day during the year. The wage rate of the farm-related households was less than other non-farm households. Farm wage varies between peak and lean seasons. Non-farm wage follows the same pattern.

Non-farm earning members' wage rate increased during peak seasons and decreased in the lean periods but mainly wage rate increased just after harvesting of Aman and Boro paddy i.e in the month of December and June. Sales workers, service workers, production workers, transport workers and labourers' wage rate was Tk. 159, 71, 151, 171 and 19 per day, respectively. Rural non-farm employment participation can play a more important role in increasing wage or return and income opportunities. Increasing income can play important role in reducing hardship during lean season and poverty for all time. Rural non-farm employments can also develop intersectoral linkages. Promoting rural non-farm employment is therefore an necessary option through providing skill training to the farm workers in different trades.

5. Recommendations

1. Landless poor farm earning members are not skilled in rural non-farm activities. To address unemployment problem during the slack season, it is necessary to provide skill training in rural non-farm enterprises so that they may engage themselves in non-farm activities at this time. To do this on a sustained basis it is needed to set up informal skill development and vocational training centres in the vicinity of the rural towns, hat and bazaar.

2. The present trend of government investment in power sector, especially electricity and gas, as well as in roads and digital communication facilities needs to be sustained with adequate budgetary provision.

3. For farm related non- farm worker, provision of non-farm enterprise training needs to be synchronized with seasonality of farm operations together with easy and adequate provision of working capital and marketing of non-farm products and services.

Reference

1. BBS, 1996. *Report on labour force survey,* 1995-96, Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

2. BBS, 2008. *Report on labour force survey,* 2005-06, Bangladesh Bureau of Statistics, Planning Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

3. Lanjouw, P and A. Shariff. 2002. *Rural non-farm employment in India: Access, income and poverty impacts.* Working paper series No. 81, National Council of Applied Economic Research, New Delhi.

4. World Bank, 2002. *Poverty in Bangladesh: building on progress. Report No. 2*4299-

5. BD. 3 p.

Appendices

Appendix Table 1: Village wise Landless Non-Farm Households Selection

Classification of Households	Landless NFHH	Sample HHs
Daulatpur Village		
Farm Related NFHH having no cultivable land	8	4
Other NFHH having no cultivable land	22	11
Total of Daulatpur	30	15
Jabarhat Village		
Farm Related NFHH having no Cultivable land	10	5
Other NFHH having no Cultivable land	21	11
Total of Jabarhat	31	16
North Noyapara Village		
Farm Related NFHH having no Cultivable land	3	2
Other NFHH having no Cultivable land	13	7
Total Households of N. Noyapara	16	9
All Villages		
Farm Related NFHH having no Cultivable land	21	11
Other NFHH having no Cultivable land	56	29
Total Households	**77**	**40**

Source: *Field Survey, July-June 2007-2008*

Appendix Table 2: Earning Members According to Farm and Non-Farm Employment Share

	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
(a) Farm Employment (FE)	2	5	7	2	4	6	1	2	3	5	11	16
FE as percent of all	11	50	25	17	57	32	6	40	13	10	50	23
(b) Non-Farm Employment(NFE)	16	5	21	10	3	13	17	3	20	43	11	54
NFE as percent of all	89	50	75	83	43	68	94	60	87	90	50	77
Total (a+b)	18	10	28	12	7	19	18	5	23	48	22	70
No. of HHs			15			9			16			40
Earning members per HH			1.87			2.11			1.44			1.8

Source: *Field Survey, July-June 2007-2008*

Appendix Table 3: Distribution of Farm and Non-Farm Earning Members According to Types of Employment

Employment Type	*Daulatpur*			North Noyapara			Jabarhat			All		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
All earning members												
Agril Labour	2	5	7	2	4	6	1	2	3	5	11	16
(a) Farm Workers(FW)	**2**	**5**	**7**	**2**	**4**	**6**	**1**	**2**	**3**	**5**	**11**	**16**
FW male and female %	**29**	**71**	**100**	**33**	**67**	**100**	**33**	**67**	**100**	**31**	**69**	**100**
Sales workers (SW)	4	1	5	3	1	4	6	1	7	13	3	16
SW as percent of NFW	25	20	24	30	33	31	35	33	35	30	27	30
Service workers (SEW)	0	0	0	1	0	1	1	1	2	2	1	3
SEW as percent of NFW	0	0	0	10	0	8	6	33	10	5	9	6
Production workers (PW)	7	1	8	4	0	4	6	0	6	17	1	18
PW as percent of NFW	44	20	38	40	0	31	35	0	30	40	9	33
Transport workers (TW)	4	0	4	2	0	2	4	0	4	10	0	10
TW as percent of NFW	25	0	19	20	0	15	24	0	20	23	0	19
Labourers/Helpers (L/H)	1	3	4	0	2	2	0	1	1	1	6	7
L/H as percent of NFW	6	60	19	0	67	15	0	33	5	2	55	13
(b) Non-Farm Workers (NFW)	**16**	**5**	**21**	**10**	**3**	**13**	**17**	**3**	**20**	**43**	**11**	**54**
NFW male and female %	**76**	**24**	**100**	**77**	**23**	**100**	**85**	**15**	**100**	**80**	**20**	**100**
Total (a+b)	**18**	**10**	**28**	**12**	**7**	**19**	**18**	**5**	**23**	**48**	**22**	**70**
Total male and female %	**64**	**36**	**100**	**63**	**37**	**100**	**78**	**22**	**100**	**69**	**31**	**100**

Source: *Field Survey, July-June 2007-2008*

Appendix Table 4: Household Earning Members according to Self and Wage Employment

Village	Agril wage employment	Non-farm wage employment	Self employment	Total
Daulatpur	6	4	18	28
	(21)	(14)	(64)	(100)
North Noyapara	6	2	11	19
	(32)	(11)	(58)	(100)
Jabarhat	3	3	17	23
	(13)	(13)	(74)	(100)
Total	15	9	46	70
	(21)	(13)	(66)	(100)

Source: *Field Survey, July-June 2007-2008, Figure in the parenthesis indicates percentage*

Bangladesh
Journal of
Political
Economy

© 2013 Bangladesh Journal of
Political Economy
Vol. 29, No. 1, June 2013, pp. 305-324
Bangladesh Economic Association
(ISSN 2227-3182)

An Empirical Evaluation of Government Paddy and Rice Procurement Programmes in Bangladesh : Policy Implications for Food Security

MD. NAHID SATTAR*
M. A. SATTAR MANDAL*

Abstract *The main aim of this study was to evaluate the performance of the government paddy and rice procurement programmes in Bangladesh with respect to understanding its contribution to food security of the country. The results showed that although the rice procurement programme could meet its target in most years, the paddy procurement programme could hardly do so. The analysis demonstrated that it was unlikely that farmers were receiving direct price support as very few of them did or could participate in the procurement system directly. Besides, the procurement prices announced by the government did not cover some transaction costs that were involved when farmers sold to procurement centres. However, the millers were able to receive direct support. The analysis showed that the procurement operations may have provided indirect price support to farmers and millers by influencing market prices. This research observed that farmers believed that the procurement price does not offer them sufficient incentive to sell at government depots. They also thought that the rules for selling at the procurement centres were difficult for them to follow and there were irregularities in the procurement system. The study concluded that although the government paddy and rice procurement programmes were contributing in ensuring food security of the country through building food stock, improvements in the system are necessary for a more efficient and farmer friendly system.*

* The authors are Lecturer and Professor of Dept. of Agricultural Economics, Bangladesh Agricultural University, Mymensingh respectively. The paper is from the MS thesis of the first author, submitted to the Dept. of Agril. Econ., BAU, Mymensingh.

1. Introduction

1.1 Background

Public intervention in the agricultural market is an area of discourse around the world. In Bangladesh, government interventions like fertilizer subsidy, public food procurement and distribution and fuel subsidies have attracted considerable economic and political interest. These interventions influence the market (prices) and have welfare implications for both producers and consumers. One of the largest government interventions in the food and agricultural system in Bangladesh is the public food operations, which consists of a procurement system, a storage system, and the public food distribution system, with inter-linkages between all of them. In this study, an attempt has been made to evaluate the procurement systems of paddy and rice from a practical and operational point of view.

Rice in Bangladesh (which is the single most important crop in terms of both production and consumption) is not immune from many physical and economic challenges. Cobweb model tells us that the farmers can be the prey of a disturbing price cycle. When low production leads to high prices one year, the farmers are encouraged to grow that crop next year. Sometimes, due to the uncoordinated actions of the farmers, there is over production and thus a reduction in prices in the next year. The cycle goes on as in the next year again there is low production and high prices. The existence of such yearly price fluctuation is harmful for the farmers and the food security of the country. The government paddy and rice procurement programmes are important intervention tools designed to provide support to producers of rice on one hand by offering price support, stabilizing prices and help consumers of rice on the other, through building sufficient stock for the public food distribution system (GoB 2010). The foodgrain procurement operations are thus a process of investment in agriculture and the rural economy in ensuring food security. However, the procurement system is subject to much criticism. Government figures and academic studies have shown that farmers' participation in the procurement process is almost insignificant (FPMU 2009; Dorosh and Shahabuddin 2002; Ashraf 2008) and some scholars have argued in favour of abolishing the system. The main objective of the study is to evaluate the performance of the paddy and rice procurement programmes in Bangladesh and understand the implications of such programmes on food security. This study refers to un-husked rice as 'paddy' and husked rice as 'rice'.

1.2 Government Paddy and Rice Procurement Programmes in Bangladesh

The public food operations were first introduced in undivided Bengal 1943 in the wake of an unprecedented famine (Sen 1982). The introduction of the public distribution system necessitated storage facilities and procurement operations to run the system properly. Since its inception, the nature and function of the public food operations have changed over the years. Currently, the procurement programmes for paddy and rice are twice every year (during harvesting time of Aman and Boro rice) and once a year for wheat. According to the foodgrain procurement policy, the paddy has to be collected from the farmers at the Local Sales Depots or Central Sales Depots and no temporary sales centres can be used for this purpose. Paddy has to be bought from farmers during the announced period in the procurement centres on "first come first serve" basis. In the case of rice procurement, the main difference is that the rice is collected from the millers on the basis of a contract.

2. Methodology

In this study, both primary and secondary data were used for analysis. Descriptive statistics and regression analysis were used to analyze the data. The findings were then interpreted and presented through tables, graphs and charts.

As this study was based on evaluating the government rice and paddy procurement system, which operates throughout the country, some of the data necessary for the study was macro level data. The necessary secondary data were collected from government and non-government institutions and books, publications or websites of these institutions. The most notable institution was the Food Planning and Monitoring Unit of the Ministry of Food and Disaster Management in Bangladesh. However, in order to conduct some in-depth analysis of farmers' and millers' participation and perception of the system, surveys had to be conducted. Due to limited time and scope of this research the survey could not be conducted throughout the country. So, the Sadar and Muktagachha Upazilas of Mymensingh district were purposively selected for the study. Two surveys were conducted, one for a group of 30 farmers and one for a group of 15 millers, the first one around the Central Sales Depot (CSD) of Mymensingh Sadar Upazila and the second one around the Local Sales Depot (LSD) of Muktagachha Upazila. A number of government officials associated with paddy and rice procurement in Mymensingh district were also interviewed. Primary data was collected during the months of June, July and August in 2010.

Simple correlation and multiple regression analysis were done to estimate relation and/or dependence among variables. The model used for regression analysis is:

$$Y = aX_{it}^{b}i$$

The dependent variable used in the regression analysis of this research is the real domestic farmgate price of paddy (Y_f). The independent variables are real procurement price of paddy (X_{pp}), world market price of foodgrain (X_{wp}), and real agricultural wage (X_{aw}). So the estimated model is,

$$Y_{ft} = a + b_1X_{ppt} + b_2X_{wpt} + b_2\, X_{awt} + u_t \text{ .... } (2.1)$$

All the variables have a ‘t’ subscript since the data is time series. Again, because of the data being time series, the Augmented Dickey–Fuller unit-root test is used to test the stationarity of the series of variables. Statistical software STATA is used for analysis.

The Benefit Cost Ratio (BCR) is calculated to observe the profitability of producing paddy and selling to procurement centers. Since the BCR is calculated for each single year for three years, undiscounted BCR is used.

3. Evaluation of The Government Paddy and Rice Procurement Programmes

3.1 Fulfillment of Procurement Target

If the data for target and actual fulfillment rates of the procurement quantities for both rice and paddy is observed, it can be seen that over the years the rate of fulfillment of procurement targets has fluctuated for both paddy and rice, but it has faced worse situation for paddy as compared with rice.

Table 3.1 shows that the paddy procurement targets are significantly lower than rice procurement targets in both boro and aman seasons during most of the years under study. The average paddy procurement target was 102.47 thousand metric tons while the average rice procurement target was 161.27 thousand metric tons during the aman season. On the other hand, during the boro season average rice procurement target was 657.34 thousand metric tons as opposed to an average paddy procurement target of 157.27 thousand metric tons. Combining both seasons for the period between 1995 and 2009, paddy procurement targets were only 33 percent of the rice procurement targets. Data suggest that government has been more interested in rice procurement than paddy procurement over the years, which is surprising given the fact that the first objective of the government foodgrain procurement policy in Bangladesh is to “provide price support to the producer farmers” (GoB 2010). Also the National Food Policy states that,

Table 3.1: Target and fulfillment rates for government Aman and Boro procurement programmes

Year	Aman				Boro			
	Paddy		Rice		Paddy		Rice	
	Target '000 tonnes	% Achieved	Target '000 tonnes	% Achieved	Target '000 tonnes	% Achieved	Target '000 tonnes	% Achieved
1994	-	-	-	-	38	14.32	225	71.33
1995	75	0.22	150	27.67	75	33.80	250	60.36
1996	152	66.51	149	89.93	53	94.96	385	99.71
1997	270	0.20	120	0.17	200	94.65	120	100.42
1998	75	0.05	200	0.00	203	37.60	282	75.99
1999	75	20.79	200	112.00	150	100.47	500	101.30
2000	73	73.73	200	99.70	154	87.27	500	102.52
2001	146	8.66	150	68.93	154	84.29	500	80.44
2002	146	0.45	100	18.37	154	52.49	600	96.07
2003	73	23.29	150	88.00	154	63.53	750	92.07
2004	73	0.004	150	0.00	154	24.66	700	103.20
2005	42	0.01	175	47.56	39	50.13	977.5	93.96
2006	37	0.01	175	93.03	300	4.83	1000	102.50
2007	75	0.00	150	0.00	300	2.11	1000	70.20
2008	75	18.61	150	102.29	300	15.71	1200	94.74
2009	150	0.21	200	7.24	95.66	100.02	1135.32	99.86
2010	-	-	-	-	150	5.71	1050	53.06

Source : *FPMU 2012*

To give adequate production incentives for increased domestic production and to enhance farmer's income, the government efforts are in place in procuring foodgrains in the intensive procurement zones at prices higher than the average production costs. (MoF 2006 p. 7)

Since rice is bought from the millers, the producer during the aman season for 15 years from 1995 to 2009, paddy procurement target has been fulfilled more than 25 percent in only two years and only 14.18 percent on an average. During the same period, aman rice procurement target has been fulfilled by more than 50 percent during seven years and 50.33 percent on an average. Although the overall rate of target fulfillment is very low, it is clearly worse for paddy procurement as compared to rice procurement. On the other hand, during the boro season for 17 years from 1994 to 2010, paddy procurement target has been fulfilled more than 50 percent in nine years and only 50.97 percent on an average. On the other hand, during the same period, boro rice procurement target has been fulfilled by more than 75 percent during thirteen years and 88.10 percent on an average. Although the overall rate of target fulfillment is very low, it is clearly worse for paddy procurement as compared to rice procurement.

If Boro and Aman procurement rates are compared, it will be observed, on an average, both rice and paddy procurement is more successful during the boro season. This can be due to a number of factors like vulnerability of the aman crop to floods and more production during the boro season in recent years as compared to the aman season. Shahabuddin and Islam (1999) mentioned that it is easier to predict the size and future price of the irrigated boro rice than it is for the aman, which is grown during the monsoon. Also, flooding in Bangladesh (which occurs mostly during the months of July-August) damages a significant part of the aman crop in some years. This was the main reason for very poor target achievement of aman paddy and rice procurement during 1997, 1998, 2004 and some other years. Since boro rice is cultivated during the dry season, it is less vulnerable to floods.

Another contrast found here is the difference in target fulfillment between paddy and rice. This point will be discussed in the later parts of this section. This study illustrates that despite being two parts of the same programme, paddy and rice procurement occurs in different circumstances and thus there rates of success are different.

3.2 Price Support for Farmers by Foodgrain Procurement Programme

The prices received by the farmers in most developing countries like Bangladesh are restricted by various deficiencies of infrastructure and market imperfections (MoA 2006, Fan et al 2002, Ahmed and Hossain 1990). Since rice cultivation is the profession of a large portion of the people of Bangladesh (mostly in rural areas), if the rice farmers do not get appropriate price for their product, a large section of the population is adversely affected. Also if the price is not remunerative for the farmers during one season, they can be discouraged to grow during the next season and putting the national production requirements and food security at risk. So, the first objective of the food procurement policy of Bangladesh is to provide price support to the producers. The government is supposed to set the procurement prices in such a way that the farmers and millers get price support.

In Tables 3.2 cost and return data for 2003/04, 2004/05 and 2005/06 from FPMU (2009) is used to show that, according to government calculations, farmers are supposed to get price support from the procurement programmes. From the Table 3.2 it can be seen that a farmer would be earning more than Taka 3000 per acre if he or she sells to government procurement centers during 2003/04 and 2004/05, and earning Taka 978 per acre during 2005/06 Aman seasons. Similarly, if a farmer sells to government procurement center, he or she would be earning more than Taka 4000 per acre during 2003/04, around Taka 2500 per acre during 2004/05, and more than Taka 3000 per acre during 2005/06 Boro seasons.

Table 3.2: Cost and Return of HYV Paddy Production

Items	**2003/04**		**2004/05**		**2005/06**	
	Aman Cost /Acre (Taka)	**Boro** Cost /Acre (Taka)	**Aman** Cost /Acre (Taka)	**Boro** Cost /Acre (Taka)	**Aman** Cost /Acre (Taka)	**Boro** Cost /Acre (Taka)
Inputs						
Seed/Seedling	270	270	300	375	345	375
Fertilizer						
- Urea	360	516	365	559	423	559
- TSP	448	490	465	560	393	578
- MOP	200	250	225	312	313	338
- Gypsum	75	100	52	100	75	110
- Zinc	120	120	88	120	120	120
- Manure	200	250	240	500	1000	500
Pesticides	350	350	350	500	500	500
Irrigation	300	3100	350	4000	1000	4000
Land Preparation	1200	1200	1200	1500	1500	1600
Labour						
- Family (mandays)	1400	1600	1500	1800	2500	2000
- Hired (mandays)	2380	3200	2550	3600	3500	4000
Interest on Capital	98	162	162	303	303	317
Land Rental	2400	2400	2400	3500	3500	3500
Total Cost/Acre	9801	14008	14008	17729	17729	18496
Net Cost/Acre (deducting value of straw) [A]	9201	13168	13168	16889	16889	17446
Return for Selling to Government Paddy Procurement Programme	Return /Acre (Taka)	Return /Acre (Taka)	Return /Acre (Taka)	Return /Acre (Taka)	Return /Acre (Taka)	Return /Acre (Taka)
Gross Return [B]	12900	17640	13413	19425	16000	20475
Net Return [B-A]	3699	4472	3804.5	2536	978	3029
BCR [B/A]	1.4	1.34	1.4	1.15	1.07	1.17

Source : *FPMU 2009*

The BCR (Benefit Cost Ratio) was calculated for selling paddy to procurement centers after deducting the value for straw. The BCR for all the three years in Table 3.2 for both Aman and Boro seasons was greater than one, meaning selling at the procurement price was profitable during those years.

However, some studies have indicated that the food procurement programme is not totally successful in providing price support to farmers. For example, Ashraf (2008) has showed in an empirical study that the rice producers are 'unlikely benefitted' from the food procurement policy for a number of reasons. In another study, Rahman and Mahmud (1988 p. 202) mentioned that due to the government procurement programme, "the welfare loss of the producers on average was 15.67 percent" (cited in Ashraf 2008 p. 87).

In this research, the influence of government procurement programme as price support to farmers will be assessed in two dimensions: direct support and indirect support. In terms of direct price support to farmers, it is difficult to claim that the government procurement programme is effective in providing such a facility to the farmers, because lack of incentives and other factors prevent most farmers from actually participating in the government procurement programme. Table 3.1 clearly indicates the lack of involvement of the farmers in the procurement process. The reasons for non-participation of the farmers are many and some of them will be briefly discussed in the later part of this paper.

Now the study will shift its focus to judge indirect price support to the farmers by the procurement operations. Ahmed *et al* (1993) supported the indirect benefit hypothesis by saying that, "Most farmers sell their rice in the market, and procurement contributes to producers' incentives through its impact on market prices". Indirect relations are difficult to prove. However, by applying econometric measures, this study finds that there is correlation between farmgate price and paddy procurement price in Bangladesh (correlation coefficient is 0.63). However, correlation is not sufficient to prove any cause and effect relationship, so this paper has used regression analysis to observe the impact of procurement prices on farmgate price of paddy. The study has used equation (2.1) and regressed procurement price on farmgate price of paddy in a sample of 20 years' data, finding significant results. The data used in specifying equation (2.1) is for the period between 1985 and 2005. Before going into the results, a brief description of the variables will be given. The dataset is obtained from FPMU (2009), FAOSTAT (2010) and World Bank (2012).

The dependent variable in the regression is domestic farmgate price of paddy. This variable is chosen as the dependent variable since the main interest in this regression is to observe price support of the procurement programmes. The explanatory variables used in this regression are government paddy procurement price, world market price of rice, and agricultural wage. The world price of rice is basically used as the proxy of world price for paddy since world market price for paddy could not be obtained. Again, agricultural wage is a proxy for cost of production of paddy since human labour cost is the largest item among the costs of production of paddy in Bangladesh. Since the prices obtained from the original sources are nominal prices, they have been deflated by the consumer price index to obtain real prices.

Since the variables used are time series variables, they have been tested for stationarity through the Augmented Dickey–Fuller unit-root test. The results indicate that it cannot be said that the real domestic farmgate price of paddy and real world price of rice series are stationary [Appendix I.I and I.III]. However, it can be said that real government paddy procurement price and real agricultural wage series are stationary [Appendix I.II and I.IV]. So, the first differences of the real domestic farmgate price of paddy and real world price of rice were obtained and used for the regression analysis. The results obtained from STATA are shown here.

```
. reg d_rdomppprice rpprocprice d_rwrprice rwage

      Source |       SS       df       MS              Number of obs =      19
-------------+------------------------------           F(  3,    15) =   25.01
       Model |  10399.8577     3  3466.61923           Prob > F      =  0.0000
    Residual |  2079.46568    15  138.631045           R-squared     =  0.8334
-------------+------------------------------           Adj R-squared =  0.8000
       Total |  12479.3234    18  693.295743           Root MSE      =  11.774

------------------------------------------------------------------------------
d_rdomppprice|      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 rpprocprice |   1.131147   .3554193     3.18   0.006     .3735884    1.888705
  d_rwrprice |   3.495584   3.194794     1.09   0.291    -3.313959    10.30513
       rwage |  -2.135375   2.410426    -0.89   0.390    -7.273077    3.002327
       _cons |   15.10529   83.10948     0.18   0.858    -162.0384     192.249
------------------------------------------------------------------------------
```

The results demonstrate that the (real) procurement price has significant effect on the first differences (i.e., the difference between this year and previous years') of real farmgate price of paddy over the years. It can be seen from the analysis that if real procurement price is increased by one unit (Tk.), then the difference between last year's price and current year's price increases by 1.13 unit (Tk.). The coefficients for the two other variables are insignificant in this regression.

So, the empirical results suggest that procurement price may provide indirect price support to farmers. This indirect relation may work through government procurement price elevating the overall market price of paddy and thus benefitting the farmer. So, this discussion can be concluded by saying that the procurement programme may not provide farmers with the specific price announced by the government, but it can be argued from these results that if there had been no procurement price, farmgate price might have dropped further.

4. Stakeholders' Perception About the Government Procurement System

4.1 Farmers' and Millers' General Knowledge about the Procurement Programmes

In this section we will have a detailed picture regarding the perception of the farmers and millers and a brief note on the local procurement officials' perception about the procurement system. Before looking into their perception about the system, it is important to know about their general degree of knowledge about the system. The following table gives us this picture for our survey of sample farmers and millers.

It can be observed from Table 4.1 that the general knowledge about the rice procurement system was more comprehensive for millers as compared to farmers

Table 4.1: Farmers' and Millers' general knowledge about the paddy and rice procurement systems respectively

Sl. No	Questions	Farmers' Responses			Millers' Responses		
		Yes	Partially	No	Yes	Partially	No
1	Have you heard about the government procurement system?	21 (70)	9 (30)	0 (0)	15 (100)	0 (0)	0 (0)
2	Do you know when Boro procurement has started and when it will end in 2010?	1 (3.33)	12 (40)	17 (56.67)	15 (100)	0 (0)	0 (0)
3	Do you know what the procurement price is this season (2010)?	14 (46.67)	8 (26.67)	8 (26.67)	13 (86.67)	2 (13.33)	0 (0)
4	Do you know about the quality requirements in paddy procurement?	2 (6.67)	15 (50)	13 (43.33)	11 (73.33)	4 (26.67)	0 (0)

Note: Figures in brackets show percentages.
Source: *Field Survey 2010*

in the paddy procurement system. All the millers were fully aware of the procurement procedure, while 70 percent of the farmers were fully aware, and the rest were partially aware. Regarding the timing of the procurement operations, all the millers were fully aware while 56.67 percent farmers had no idea about the timing. Thirteen out of fifteen millers knew exactly the procurement price for the season while only 46.67 percent farmers knew the exact price for that season.

Also, most of the millers (73.33 percent) had a good idea about the quality requirements for rice to be sold at the procurement centres while only 6.67 percent of the farmers had the same level of knowledge regarding rice procurement.

4.2 Farmers' Perception about the Government Procurement System

In Table 4.2, the details of the farmers' perception regarding the paddy procurement system obtained from the field survey is presented.

Table 4.2 shows that almost 73 percent of the respondent farmers think that the procurement price of Taka 17 per kg that season was not justified. More than two-

Table 4.2: Farmers' perception of the paddy procurement system

Sl. No.	Statements	Farmers' Responses				
		Strongly Agree	Agree	Don't know or indifferent	Disagree	Strongly Disagree
1	The Boro procurement price this season (2010) is justified	0 (0.00)	5 (16.67)	3 (10.00)	14 (46.67)	8 (26.67)
2	The quantity of paddy procured is reasonable	0 (0.00)	4 (13.33)	23 (76.67)	3 (10.00)	0 (0.00)
3	The timing of the procurement programme is appropriate	1 (3.33)	20 (66.67)	6 (20.00)	3 (10.00)	0 (0.00)
4	The procurement centres are at suitable locations	7 (23.33)	21 (70.00)	2 (6.67)	0 (0.00)	0 (0.00)
5	Transportation to procurement centre is easy	2 (6.67)	22 (73.33)	6 (20.00)	0 (0.00)	0 (0.00)
6	Procedure of selling at procurement centres is reasonable to farmers	0 (0.00)	0 (0.00)	2 (6.67)	20 (66.67)	8 (26.67)
7	The method of payment is appropriate	0 (0.00)	11 (36.67)	13 (43.33)	6 (20.00)	0 (0.00)
8	The procurement procedure is not time consuming	0 (0.00)	0 (0.00)	0 (0.00)	28 (93.33)	2 (6.67)
9	There is corruption in dealings at the procurement centres	10 (33.33)	19 (63.33)	1 (3.33)	0 (0.00)	0 (0.00)
10	The procurement system offers price support to the farmers	0 (0.00)	4 (13.33)	5 (16.67)	17 (56.67)	4 (13.33)

Note: Figures in bracket show percentages
Source: *Field survey 2010*

thirds of the respondents were satisfied with the timing of the procurement programmes and the location of the procurement centres. Transportation to the procurement centres also did not seem to bother any of the respondents. However, once the attention is focused on the functional side of buying-selling at procurement centres, we see that farmers have more adverse perception in those areas. None of the respondent farmers thought that the procurement procedure was reasonable to the farmers with 26.67 percent strongly disagreeing with the statement that the procedure is reasonable to farmers. All the farmers who knew about the system also believed that the procedure was time consuming as compared to selling to the open market. A very important aspect of the survey was that almost all the respondents believed that there was corruption at the procurement centres. Many farmers believed that their products will not be accepted at the procurement centres (irrespective of whether they are of proper quality or not) unless some informal payments are made to the staff at the procurement centres.

It has been mentioned previously that the farmers' decision to sell at the procurement center or in the open market was influenced not only by the comparison between market prices and procurement prices, but also by the involvement of some transaction costs. Although Table 3.3 of this paper showed that the procurement price for paddy was good enough to cover the average cost of production, the government stipulated price does not account for the transaction costs that are involved with selling to procurement centers. There can be transaction costs in all economic transactions, and it is true for selling at both the open market and the procurement centers. One very common cost item that can be regarded as a transaction cost is the transportation cost. If a farmer is selling at the farmgate, then the transportation cost is naturally lower than selling at the procurement centers. However, if the farmer has to sell at a nearby market, then the transportation cost can be high or low in case of either option. A study by Sabur et al (2003) on paddy and rice procurement in four Upazilas of Naogaon and Bogra districts showed that the transportation cost was higher for the farmers if they sold to procurement centers.

Another vital reason for farmers' reluctance to participate in the government procurement programme is the difficult rules and regulations of the system. Many farmers are uncomfortable with such rules and regulations. In our field survey almost 73 percent of the farmers were found to be partially or totally unaware of the detailed rules and regulations of procurement procedure and 93 percent felt that the system was not reasonable for the farmers. Previous studies evaluating the government procurement system have also mentioned the stiff rules and regulations as hindrances for farmers to participate in the system (Sabur et.al. 2003; Shahabuddin and Islam 1999). Due to this ignorance and subsequent failure to comply with quality regulations, sometimes farmers have been rejected at the doors of the procurement centers. This risk of being denied at the procurement center can be considered as an element of the transaction cost for the ordinary farmer, because he will travel to the procurement center only if he feels that the price incentive there is larger than the price received outside plus a 'risk premium' for being rejected at the procurement center.

Apart from these formal or legal factors, there is an 'informal' factor which also prevents farmers from participating in the government procurement process. A significant proportion of farmers (29 out of 30) in this study reported that there is corruption at the procurement centers. Many farmers participating in the study reported that staff at the procurement centers would deny them selling to the procurement centers unless they are provided with some 'remuneration'. Two different studies- one by Shahabuddin and Islam (1999) and the other by Sabur et. al. (2003) - evaluating government foodgrain procurement programme in different districts mentioned that 'unofficial' payments were at times reported to be necessary for any farmer to be able to participate in the government procurement system. Whether these claims were true or not were not verified in this study, but the survey for this study shows that many farmers 'believed' that such problems existed, which means that their decision to sell at procurement centers would be influenced by such 'beliefs'. So the farmers would be willing to sell to the procurement centers only if the price they receive there is sufficient enough to cover not only their cost of production but also a 'risk premium' for being refused at the gates of the procurement centers for legal reasons plus an amount for informal payment at the procurement center. The previous statement can be illustrated better through the expressions in text box 4.1.

A number of farmers under study alleged that apart from preventing them to participate in the government procurement procedure, the rigid rules and existence of corruption at the procurement centres facilitated the creation of a group of non-farmers or large farmers who would have

Text box 4.1: Understanding farmers' behaviour of non-participation in the procurement system

If,

P_p = Procurement price

P_m = Market price

r = Risk premium for refusal at procurement centers

p_i = Informal payment at the PCs

A farmer will not sell even if $P_p > P_m$ but rather if,

$$P_p > P_m + r + p_i \quad \ldots\ldots\ldots\ldots (4.1)$$

i.e., a farmer will only sell to procurement centres if he believes that the procurement price is larger than not only the market price but actually only if it is larger than the market price plus the risk premium for rejection at the procurement centres plus the informal payment required at the procurement center.

access to the procurement centres and reap the benefits from the system. This is an indication of elite capture of the government procurement centres.

4.3 Millers' Perception about the Government Procurement System

The perception of the millers regarding the rice procurement system was also different from the farmers' perception about the paddy procurement system. Their responses are depicted in Table 4.3. From the Table it can be seen that almost 46.67 percent of the respondent millers thought that the procurement price of Taka 25 per kg for rice was not justified. There was wide divergence of opinion regarding allotment of quota for the millers. More than 46 percent of the respondents thought the quota allocation procedure was not fair and the same proportion thought the allotted quotas were not reasonable. However, 26 percent were satisfied with the allotment procedure, while 40 percent were satisfied with the allotted quota.

Interestingly, the millers were evenly divided in their opinion regarding the procedure of selling to the procurement centres with one third of them agreeing that the procedure was reasonable for the millers, one third disagreeing with the statement, and one third indifferent about it. Most of the millers (60 percent) were indifferent about the method of payment, while almost 32 percent were satisfied. Even though the millers were more satisfied with the system as compared to farmers, about 63 percent of them still complained that there was corruption at the procurement centres. None of the respondents believed that the rice procurement system offered price support to the millers with two thirds clearly indicating that it did not do so.

4.4 The Procurement Centre Officials' Perception

As mentioned earlier, the District Controller of Food in Mymensingh, Deputy Director of Agriculture at the DAE for Mymensingh district, Officers in Charge of two procurement centers and some other staff at the Upazila Food Office in Mymensingh were interviewed for this study. According to their opinion, the procurement system was running properly, although there might be some minor problems. They blamed the farmers for not being able to maintain proper quality standards as the reason for lack of participation by farmers. They argued that since the millers were more educated, knowledgeable and conscious, they could maintain the standards for rice, and so there were no major problems in rice procurement. The officials also denied any corruption at the procurement centers.

5. Conclusions and Policy Recommendations

5.1 Conclusions

This study was undertaken to evaluate the performance of government paddy and rice procurement programmes in Bangladesh with respect to understanding its

Table 4.3: Millers' perception about the rice procurement system

Sl. No.	Statements	Millers' Responses				
		Strongly Agree	**Agree**	**Indiffe rent**	**Disagree**	**Strongly Disagree**
1	The procurement price this season is justified	0 (0.00)	1 (6.67)	1 (6.67)	7 (46.67)	6 (40.00)
2	**Error! Not a valid link.**	0 (0.00)	4 (26.67)	4 (26.67)	5 (33.33)	2 (13.33)
3	The allotted quota for rice is reasonable	0 (0.00)	6 (40.00)	2 (13.33)	7 (46.67)	0 (0.00)
4	The timing of the procurement programme is appropriate	2 (13.33)	8 (53.33)	5 (33.33)	0 (0.00)	0 (0.00)
5	The procurement centers are at suitable locations	0 (0.00)	7 (46.67)	7 (46.67)	1 (6.67)	0 (0.00)
6	Transportation to procurement center is easy	0 (0.00)	4 (26.67)	10 (66.67)	1 (6.67)	0 (0.00)
7	Procedure of selling at procurement centers is reasonable to millers	0 (0.00)	5 (33.33)	5 (33.33)	5 (33.33)	0 (0.00)
8	The method of payment is appropriate	1 (6.67)	4 (26.67)	9 (60.00)	1 (6.67)	0 (0.00)
9	There is corruption in dealings at the procurement centers	2 (13.33)	8 (53.33)	2 (13.33)	3 (20.00)	0 (0.00)
10	The procurement system offers price support to the farmers	0 (0.00)	0 (0.00)	5 (33.33)	10 (66.67)	0 (0.00)

Note: Figures in bracket show percentages
Source: *Field survey 2010*

contribution to ensuring food security. The programmes were evaluated in different dimensions. First of all, it was shown through data that although the rice procurement programme could meet its target in most years, the paddy procurement programme could hardly do so. The next aspect of measuring of success was to judge whether the procurement system offered price support to the producers. By analysing secondary data on cost of production it appeared that theoretically farmers were supposed to receive price support from the procurement programmes since their average cost of production was covered by procurement prices. Also, through regression analysis it was shown that procurement programme may offer indirect price support to farmers as the real procurement price has significant positive effect on the first difference of real farmgate paddy price. However, this research showed that it was unlikely that farmers were receiving direct price support as very few of them did or could participate in the procurement system directly. The procurement prices announced by the government did not consider some transaction costs that were involved if farmers sold to procurement centres. However, the millers were able to receive direct support as they could sell directly to the procurement centres. The study also observed the farmers' and millers' perception of the system. The findings suggested that most farmers believed that the procurement price did not offer them sufficient incentive to sell at government depots, the rules for selling at the procurement centres were too difficult for them to follow, and there were irregularities in the procurement system. The millers, on the other hand, had better knowledge and perception about the rice procurement system. However, they also thought that the system did not provide price support and believed that there were irregularities in the system.

The government paddy and rice procurement programmes are contributing in the process of ensuring food security of the country by supplying foodgrain to the public food distribution system and providing indirect price support to farmers. However, the government should be careful in ensuring that the benefits of such costly programmes are reaching those for whom they are intended and take steps to make the procurement process more farmer friendly.

5.1 **Policy Recommendations**

The following recommendations are made based upon this research:

1. The procurement programme should have provisions to publicize as well as educate farmers about the quality requirements for selling paddy to procurement centres so that they are not refused at the gates of the depots. If the farmers are aware of the rules and collectively attempt to participate then they will have better bargaining power and better chances of benefitting from the system.
2. The government can take other steps to increase the participation of the farmers in the system. If the procurement operations can be further decentralized at the local level then the transaction costs that are involved can be minimized and thus provide incentive for farmers to participate in the government foodgrain procurement system.
3. There are many allegations of irregularities in the system. The presence of any irregularity in such a large government intervention programme is bound to cause misuse of public resources on one hand and prevent the programme to fulfil its objectives on the other. The government should investigate and take necessary measures to solve these irregularities in the system, if there are any.

References

1. Ahmed, R. and Hossain, M. (1990). "Development Impact of Rural Infrastructure in Bangladesh". Research Report 83, International Food Policy Research Institute, Washington, DC.

2. Ahmed, R., Chowdhury, N. and Ahmed, A. U. (1993). "Determination of Procurement Price of Rice in Bangladesh". Working Papers on Food Policy in Bangladesh, No.6, International Food Policy Research Institute. Washington, DC.

3. Ashraf, M. A. (2008). "Econometric Analysis of the Impact of Domestic Rice Procurement Policy on Producer Price: The Case of Rice in Bangladesh". *Journal of Agro Economy*, Vol. 26 (1): pp. 80- 89.

4. Dorosh, P.A. and Farid, N. (2003). "Implications of Quality Deterioration for Public Foodgrain Stock Management and Consumers in Bangladesh". MSSD Discussion Paper No. 55, International Food Policy Research Institute, Washington, DC.

5. Dorosh, P.A. and Shahabuddin, Q. (2002). "Rice Price Stabilization in Bangladesh: An Analysis of Policy Options". MSSD Discussion Paper No. 46, International Food Policy Research Institute, Washington, DC.

6. Fan, S., Zhang, L. and Zhanggrowth, X. (2002). "Inequality and Poverty in China the Role of Public Investments". Research Report 125, International Food Policy Research Institute, Washington, DC.

7. FAOSTAT (2010). "PriceSTAT". Food and Agriculture Organization of the United Nations. Available online: http://faostat.fao.org/site/570/ Desktop Default.aspx?PageID=570#ancor. [Accessed 20/07/2010]

8. Farid, N. and Rahman, M.S. (2002). "Procurement planning and price stabilization for the public foodgrain distribution system in Bangladesh".

9. FPMU (2009). "Database on Food Situation". Food Planning and Monitoring Unit, Ministry of Food and Disaster Management, Government of Bangladesh.

10. Government of Bangladesh (2010). "Domestic Foodgrain Procurement Policy". Department of Food, Ministry of Food and Disaster Management, Government of the People's Republic of Bangladesh.

11. Ministry of Food and Disaster Management (2006). "National Food Policy 2006". Government of the People's Republic of Bangladesh.

12. Rahman, A. and Mahmud, W. (1988). "Rice Market Intervention in Bangladesh" In Evaluating Rice Market Intervention Policies, Asian Development Bank, Manila, Philippines.

13. Sabur, S.A., Jahan, H. and Reza, M.S. (2003). "An Evaluation of Government Rice Procurement Programme in Selected Areas of Bangladesh". *Bangladesh Journal of Agricultural Economics*, Vol. XXVI (1&2): pp. 111-126.

14. Sen, A. (1982). "The Food Problem: Theory and Policy". *Third World Quarterly* 4: 447-459.

15. Shahabuddin, Q. and Islam, K. M. N (1999). "Domestic Rice Procurement Programme in Bangladesh-An Evaluation". Food Management and Research Support Project. Dhaka, Bangladesh.

16. World Bank (2012). "World Development Indicators and Global Development Finance". World Data Bank. The World Bank Group. Available online: http://databank.worldbank.org/ddp/ home.do?Step=12&id=4&CNO=2

APPENDIX I

1.1 Augmented Dickey–Fuller test for real domestic farmgate price of paddy

```
. dfuller rdomppprice, reg trend

Dickey-Fuller test for unit root                   Number of obs   =        19

                               ---------- Interpolated Dickey-Fuller ----------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic          Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -1.605            -4.380            -3.600            -3.240
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.7905

------------------------------------------------------------------------------
D.rdompprice |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  rdompprice |
         L1. |  -.4088504   .2547683    -1.60   0.128    -.9489351    .1312342
      _trend |  -1.161219   1.192075    -0.97   0.344    -3.688305    1.365866
       _cons |   51.70645   38.46525     1.34   0.198    -29.83622    133.2491
------------------------------------------------------------------------------
```

1.2 Augmented Dickey–Fuller test for real procurement price of paddy

```
. dfuller rpprocprice, reg trend

Dickey-Fuller test for unit root                   Number of obs   =        19

                               ---------- Interpolated Dickey-Fuller ----------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic          Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -3.824            -4.380            -3.600            -3.240
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0154

------------------------------------------------------------------------------
D.rpprocpr~e |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 rpprocprice |
         L1. |  -.8807808   .2303386    -3.82   0.001    -1.369077   -.3924849
      _trend |  -2.365314   .6218463    -3.80   0.002    -3.683569   -1.047059
       _cons |   124.8239   33.00323     3.78   0.002      54.8602    194.7877
------------------------------------------------------------------------------
```

1.3 Augmented Dickey–Fuller test for real world price of rice

```
. dfuller rwrprice, reg trend

Dickey-Fuller test for unit root                   Number of obs   =        19

                               ---------- Interpolated Dickey-Fuller ----------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic          Value             Value             Value
------------------------------------------------------------------------------
 Z(t)             -2.650            -4.380            -3.600            -3.240
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.2572

------------------------------------------------------------------------------
  D.rwrprice |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    rwrprice |
         L1. |  -.4451845   .1679651    -2.65   0.017    -.8012546   -.0891144
      _trend |  -.1253801    .046781    -2.68   0.016    -.2245515   -.0262087
       _cons |   3.187237    1.21724     2.62   0.019     .6068024    5.767671
------------------------------------------------------------------------------
```

1.4 Augmented Dickey–Fuller test for real agricultural wage

```
. dfuller rwage, reg trend

Dickey-Fuller test for unit root                   Number of obs   =        19
```

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.357	-4.380	-3.600	-3.240

MacKinnon approximate p-value for Z(t) = 0.0574

D.rwage	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
rwage						
L1.	-.3199721	.0953169	-3.36	0.004	-.522035	-.1179093
_trend	-.0168022	.0328173	-0.51	0.616	-.0863717	.0527673
_cons	8.72073	2.262308	3.85	0.001	3.924852	13.51661

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 325-352
Bangladesh Economic Association
(ISSN 2227-3182)

Peasant Power and Politics in a Bangladesh Village

MIHIR KUMAR ROY*
SALAH UDDIN IBNE SYED**

Abstract *Bangladesh is a land of thousands of peasant farm families. The country is predominantly an agrarian society. A major portion of its population depends on agriculture, known as peasants.*

Peasant society owns a traditional power structure and some specific social organization that influence the production system and livelihood of that class of people. Faction grouping and political change also influence farm household activities. This study was undertaken to focus on the peasant faction grouping and power structure at the village Heshakhal under Nangolkot Upazila of Comilla district. The major focus of the study was to comprehend the change occurring in social organizations within the peasant society, on faction grouping and also the changing power structure of the village.The study reveals how in last forty years a major change occurred in the traditional power structure of the village. In the last century, the villages were divided in three Samaj. Linkage with formal administrative unit was flexible. Salish system was the major feature of conflict resolution, specially in managing social conflict. At present the village is separated into several Samajs. The role of Samaj is decreasing day by day. Influence and role of national level political parties are also playing a strong role in leadership in the village, which was not seen thirty years ago.A major change was also seen in the social organization of the village. In the village, peasant families that once depended on agriculture are how trying to engage their manpower in non-farm activities. Marriage system has changed, due to intermarriage system among the Swandupi and deshi community.

Keywords: *Peasants, Power Structure, Politics,Agrarian Society, Factionalism.*

* Professor & Dean, Faculty of Business Administration, City University, Dhaka.
** Deputy Director, Bangladesh Academy for Rural Development, Comilla.

1. Introduction

1.1 Statement of the issue

Bangladesh is predominantly an agrarian society. A major portion of its people's livelihood depends on agriculture. The households who are living under an agrarian setting are commonly known as *krishak* which in anthropology and development studies, are called as *peasants.* The term 'peasant' was originated by the development academicians, meaning a transitional pre-industrial class mostly depending on agriculture at the subsistence level. According to the academic point of view ,the peasantry has constituted the most numerous social group in all organized states, from ancient to modern times,that rests on traditional agriculture. (Encyclopedia of Social Science, 1977).

On economic criterion, peasant means a system of small producers, with a simple technology and equipment, often relying primarily for their subsistence on what they themselves produce. According to Eric Wolf "Peasants are farmers who grow crops and raise livestock in rural areas." A characteristic which is often stressed is that peasant societies in some sense represent a transition, that 'stands midway between the primitive tribe and industrial society' (Wolf, 1966).

According to the definition pictured by the academicians, the society of Bangladesh comprises a large portion of peasants. In the peasant society of Bangladesh some major features can be identified. These are: transition, market and exchange, subordination and internal difference. Transition implies change and adaptation but it must stress that the speed of change and its outcome are neither known nor determined in advance. Markets provide both opportunities and pressure for peasants. The idea of subordination implies unequal social and cultural status. Peasants in Bangladesh are identified as a distinctive social or economic group, and in stressing their subordination to other social groups, there is a risk of overlooking the differences in social and economic status within the peasant society itself. According to Abu Abdullah , "Bangladesh is a country of family farms .Most of the tenants depend on share cropping system" (Abdullah,. 1980). The proportions of land owned by the peasant families were never higher than the land of a large farm household. This scenario is drawn from agricultural surveys conducted in the past decades. In the last agricultural survey done in 1996 and 2005 it is found that in the decades of 60s and 70s of the last century the area of farm holding is the same. The average farm holding was 3.5 acres. But in 1982 the average farm holding decreased to 2.4 acres. The growth of population was a major cause of that. Within the period between 1996 and 2006 the average holding decreased to 1.48 acres. The process of defragmentation of land is the major cause of that. It is also found in the last survey that the rate of landless farm household have also increased. In 1960, 33% of peasants were landless. The ratio increased to 37% in 1982 and along with that the marginal farm families increased to 51.42%.The data on the number and area of farm holdings in 1996 to 2005 are shown in Table-1

Table 1: Number and Area of Farm holdings and their Percentage

Size of Farms(in acres)	Number of Farms (in thousand)		% Of Farms	
	2005	1996	2005	1996
Total Farm holdings	15089	11798	100	100
Marginal farm holdings (00.050-00.49 acres)	5829	3356	38.62	28.45
Small farm holdings (00.50-2.49 acres)	7523	6067	49.86	51.42
Medium farm holdings (02.50-07.49 acres)	1561	2078	10.34	17.61
Large farm holdings 07.50+above	177	298	1.17	2.52

Source : *Agriculture Sample Survey,2005*

1.2 Review of the Relevant Literature

In the last century village study or study on peasant society became popular among the sociologist/anthropologists of this part of the world. In Bengal, a pioneer work on peasant society was done by *Ramchrisna Mukherjee* (The Dynamics of a rural Society, 1957). His work was done in six villages of Bogra district of Bangladesh analyzing the economic and social changes occurring in peasant society during the year 1942-1944. That study first identified that the static village society was changing due to change in profession and development in communication. The study focused on the taxation, credit system of the *Mohajan*, the process of land losing of poor peasants due to credit, and the overall socio-economic situation of peasant life in East Bengal. .The study focused on the process of reinvestment of the profit gained by Mohajans and the rich farmers. These profits came from the exploitation of the peasants and was invested in buying land from the same poor peasants class. The study was a milestone in the field of village study and a turning point in social sciences research in Bengal.

Hafeez Zaidi (1970), worked on the basis of "General Survey" of the socio-psychological aspects. His study area was two villages of Comilla district. He collected information regarding the village life through survey using a schedule and through intensive field work. His studied villages were classified on the basis of landed property, education, age and power. In the study he highlighted on problems of human interaction. According to him, faction follows the kinship line but not exclusively. He also discussed on rituals, superstitions and fatalistic beliefs of the peasants of East Bengal.

The study titled "*Jhagrapur*: Poor peasants and women in a village in Bangladesh" (1977); and done by Dutch couple *Jeenek Arens* and *Jos Ven Beurden* focused on Marxist point of view of class struggle in a peasant society of Bangladesh. The study focused on the mode of production and production relation in a peasant society. Another major focus of the study was to identify the position of women in a Bangladesh village. In the study the kinship and the patron-client relation was not focused. The main focus was on the conflicting role of village social life. Another focus of the study was the relationship between men and women. They observed that the women enjoyed an inferior status. The wife was treated as personal property of her husband and she did not get recognition of her works.

Anwarullah Choudhury studied on social stratification pattern of a village in Dhaka district in 1978. This study shows that the village is stratified from three dimensions, namely class, status and power. The classes are based on the ownership of land. The Hindu Caste and Muslim status groups are arranged hierarchilly on the basis of high and low status. The village is again stratified on the basis of unequal distribution of power. In the study the researcher shows how few individuals control politics and how the rest remain out of the domain of power and politics. The basis of power in the village has also been focused. Inequality in the distribution of power is ,to a large extent, related to the inequality of ownership and control of land

The review of studies shows that from the beginning of the last century, the so called calm and static village social structure started changing. Especially at the middle of the last century, due to independence and rise of nationalism and abolishing the zamindari system, the village people had an opportunity of having access to the national level political formation. Major development initiatives were also taken in that period of time that has had a great influence in the social life of Bangladesh villages, especially in the Comilla region. In the middle of the 1970s some pioneer studies were conducted that also focused on the changing peasant society of Bangladesh. But within the last twenty years there has been a gap in understanding the changing scenario of the peasant society. This study is an attempt to fill the gap.

1.3 Objective of the Study

The broad objective of the study is to find out the changes occurring in a peasant society. and long with that, to comprehend the influence of political changes occurring in the peasant society.

In specific terms, the objectives of the study are to:

i. comprehend the traditional institution and power structure of a peasant society;
ii. analyze the changing role of faction groups in a wider context;
iii. Identify the changes in traditional power structure in the context of larger Bangladesh.

1.4 Importance of the Study

The society of Bangladesh is changing rapidly due to modernization, development of communication and globalization. Thousands of peasant families are playing a vital role in the socio-economic structure. Increase of crop production, use of new technology in agriculture sector and development initiatives taken by the GOs and NGOs are acquiring changes in the peasant societies. The political change in the capital has also been vital for bringing change in the peasant society of Bangladesh. It was pottered by many writings and myths that Bangladesh villages were calm and quite. Very little change occurred in hundred years. But in the study of peasants we find that the peasant society is always in a transition. In the last three decades major political and cultural change occurred leading to an independent state through a bloody war. After the independence, in last three decades Bangladesh adopted different types of government. Especially in the last two decades a large change has occurred from local level political unit to central level political structure. Decentralization of local govt. and introducing parliamentary form of govt. has influenced the political scenario. These changes are influencing the traditional power structure and peasant way of life. Peasant faction groups are not only involving themselves in internal village politics, but are also relating themselves with the local and national level politics. Now a day the village life is not separate and so called self sufficient. The peasant livelihood is very much dependent on government policy and programmed. In local development initiatives, political groupings and the influence of national political parties play a vital role. Those who have good relation with the local and national political institutions can easily get the benefits of development afford. This study would focus on the changing power structure and politics of the transitional peasant society.

The Bangladesh for Rural Development Council (BARD), is dealing with rural development initiatives, which is basically being implemented over the peasant society of Bangladesh. For development initiatives it is very much needed to know the internal dynamics of a society. This study would help focus on the internal dynamics of power structure of a peasant society that will be helpful for implementing new development initiatives at grassroots level.

1.5 Scope of the Study

The study focuses on two major issues: The first one is to identify traditional institutions related to the power structure. The second one is to identify changes occurring there and the influence of central political formation. For identifying these, following variables are used:

Issues	*Variables*
1. Existing Institutions	Household, Family, Bari,Gosti, Samaj, Faction groups.
2. Power structure	Decision making issues, Leadership development, factin groupings, Conflict and cohesion, Role of women leadership, etc.
3. Changing power structure	Influence of modernization, Formation of new institution, influence of political parties, new leadership, peoples mobility, gosti mobility, influence of local administrative units. etc.

Peasant society is very much covered. It is not an easy task to break out the cover and identify the problems. For that in-depth study and accurate methodological framework are needed to be built up. The study would be a micro level study covering a single village peasant community. It was not the representation of the whole scenario of Bangladesh but a case as to how things in the peasant society are changing rapidly.

2. Study Methods

The study is an anthropological type of study. Some PRA tools were used for collecting data from the field. The sources of information are basically primary. Along with that some quantities information was collected from sending data available for the agriculture extension office, administrative units of the upazila headquarters and some local NGOs. Information the land pattern, soil, classification of peasants, type and characteristics of climate and soil, ownership of land was collected from the agriculture extension department of Nangolkot upazila. The study of a village with specific objective requires a theoretical framework/background. The duration of the study was one and half years. First three months of the study were spent on building a strong theoretical background as well as selection of the study area. The team needed to stay and travel the selected village for a period of time. The team visited several villagers for selecting the specific village for collecting data.

2.1 Selection of village

The study mostly depended on some primary data collected from field. This study tried to follow the tradition of studying only one “specific village for getting the in-depth scenario of a peasant society. Primarily the study area was of some interior part of the Comilla region. After visiting several villages the village named *Heshakhal* under *Nongalkot* Upazila was selected. The special characteristics of the village were:

Firstly, the village is big in respect of population and territory. There are more then 800 families separated in different subgroups living in the village.

Secondly, the village is a complex one with a variety of people living there.

Thirdly the village is named after Union. In the power structure of the village the interrelation with the Union is present there.

Fourthly, the village consists of a large number of peasant households.

Fifthly, the village contains more then five para (neighborhoods) that maintain their own political identities in some matters, and the last cause of selecting the village is that, peasant activities still dominants are the village.

Paddy is the mostly grown crop in locality. Their economic activities are in subsistence level.

The following tools/methods were used for collecting data:

i) Observation

Observation method is the key method to closely understand issues of a community. This method was used to get idea of faction grouping, formation of groupings, power structure, and role of varios *Gosti* etc.

ii) Focus group discussion (FGD)

The FGD method was used to get qualitative information on the key issues from the studied area.

iii) Using key informants

Key informant method was used for identifying some in-depth and touchy issues relating to the objectives. Elderly members, faction group members were used as key informants. The elder one gave information about the change occurred in social and political structure of the village in the last focus decades.

v) Informal Interview

Open ended checklist was used to collect some basic information through gossiping and exchange of views.

2.2 Organization of fieldwork

The study was an anthropological/qualitative type of study. Observation was the major method that was used in the fieldwork. The research team used to stay in the field during the day time, and maintained diary, log book for accumulating data from the field.

2.3 Limitations of the Study

1) One of the limitations of the study was that the study was in a single village. The findings may not represent the whole scenario of the peasant society of Bangladesh.

2) Another limitation of the study was that the quantitative data were collected through recall method and from secondary data of agriculture department of *Nangolkot* upazila office. That might not be hundred percent accurate.

]In spite of these limitations, the researcher tried to fulfill the objectives of its study and indicate the features of a peasant society specially the characteristics of change in the power structure. That would provide some important guidelines for future research of the peasant society in Bangladesh.

3. Ecology and Social settings

3.1 Selecting of the Village

For collecting data from the field the village name *Heshakhal* was selected. It was selected for its distinct characteristics and the the presence of a large number of peasant households. The village is large in size and in number of population. Several Para and presence of several Samaj make the village attractive for the study. . The village is an ancient village where Hindu and Muslim communities are living from time immemorial. Along with that three subgroup of Muslims are living in the village. So selecting the village for studying the peasant culture and life style as well change in power structure and influence of modernization make the village attractive for study.

3.2 History of the Village

For collecting the history of the village information was gathered from the village elderly. According to the view or oral story from the most elders of the locality, *Heshakhal* village is one of the oldest settlements of the locality. The name of the village derived from the stream flowing at the southeastern part of the village. The canal is a very old water body that originated from the *Muhuri* river of *Feni* district. The canal is more then two hundred years old. The stream had created a large Jola (big swamp) in this part of *Nangalkot* region. The swamp was also famous for many varieties of local fish specially big cat fish (*Magur*). At that time fishermen communities were living on the bank of this place. The local people used to rear duck (*Hash*), because of the presence of a large water body. By the name of *Hash* the canal was named as *Hesakhal*. The village was also named as *Heshakhal*, by the name of the canal.

The Hindu population dominated the village before the separation of the Indian subcontinent. Most of the elite of the locality were Hindu family elders. The Muslim population was a minority. The Samaj leaders were mostly Hindu. Relation between the Hindu and Muslim community was good. Muslim community used to participate in the Hindu religious programmes as guests. The Hindu also used to come to Muslim festivals. Especially the lower caste Hindu had a very good relation with the Muslim as they were in the same class. In course of time the proportion of Muslim community had increased due to Muslim population from southeast portion of Bangladesh started settling in the area of Comilla. This Muslim population is locally known as *'Swondupi'*. Almost all of the in habitants were peasants. So a good working and social relation was seen among the Hindu and Muslim community at that time.

After the separation of the Indian subcontinent in 1947, the Hindu community especially the rich families started migrating to India. Most of them migrated without settling the ownership of their property. Some families migrated through exchanging their property with Muslim families willing to live in *Heshakhal* village. Thus 27 Muslim families settled in *Heshakhal*. These families are locally known as *Rewaji*. There is distinctness among the *Rewaji Deshi* and *Swondupi* Muslim community living in the village both socially and culturally. At present the Hindu communities are living at the Hindu para situated at the middle of the village. This part is one of the original settlements of the locality.

3.3 Climate

The study area *Heshakhal* is situated at the flood prone zone of Comilla district. *Hesakhal* is locally known as a paddy-growing village. According to the statement given the peasants living in the village that the soil type and its condition is favorable for growing paddy.

According to the Bangla calendar there are six seasons committing of twelve Bangla months. The dry and hot season is known as *Grismakal* (Summer) consisting Bangal month of *Baishak* and Jaista. The monsoon is known as *Barshakal* .Autumn is known as *Saratkal*, winter is known as *Seetkal* and spring is known as *Basantakal.* But to the peasant community of the studied area there are three seasons summer, Monsoon and winter are mostly important, temperature, humidity and rainfall is important for agriculture activities, especially for paddy cultivation in the village *Heshakhal*.

It was found that the peasant community living in the village is very much dependents on nature. Especially on rain, temperature and humidity. for the production of paddy along with other crops water and temperature are two major factors. During the fieldwork a Focus Group Discussion (FGD) was done among the peasant of the village. It was found that the highest temperature of the year is the summer and autumn time. Most period of the year, temperature remains moderate. In winter time temperature remains low.

Rainfall is important because rainfall means drought, and less production. A good harvest of paddy needs much rainfall during the seasons of Aush and Aman heavy rainfall. Often becomes a problem. As the area is poor in drainage of water havvy rainfall cause water logging. Water logging which sometime cause crop damage, especially in the Aman season. According to the villagers in last ten years the peasants of the locality faced four times Aman crop losing situation due to water logging caused by heavy rainfall in the locality.

3.4 Inhabitants of the village

The village *Heshakhal* is administratively situated in *Heshakal* Mouza of *Nangalkot* upazila. The village is large in size. The total land area of *Heshakhal* village is about 686 acres (including homesteads, roads, ponds, bazaar) where about estimated 825 families living. The village has two major religious groups. The Hindu and the Muslim. Muslims were a minority in respect of population before the separation of India. After 1947, the Hindu families started migrating to India in a large number. During that period two- thirds of Hindu inhabitants migrated to India. Among the migrated portion of Hindu families most of them were in rich and influential. Among them some were "*Samaj leader*" of the then time. Some families exchanged their property with Muslim families who migrated to *Heshakhal* from *Agortala* of India. These portion Muslim families are locally known as *Rewaji*. In most cases the Hindu families migrated to the India without settling their property specially land. At present only 71 Hindu families are living in *Heshakhal* village.

In field work it was found that the Muslims are major religious group in the village which on their origin can be classified into three groups:

These are:

1. *Deshi* (Original settlers of the village)
2. *Swondupi* (Originated from south western Bengal)
3. *Rewaji* (Migrated muslim from India)

The portion of Deshio community are 44.6% (368) of the total households. These people claim themselves as the original settler started living with the Hindu community from the very beginning of the village incisory. Swondupi community started settling in these region of Comilla and NGO Kuali due some natural causes. They migrated from southern part of the region and started settling here. Among the total househol 43.52% belong to Swondupi Community. Rewaji Muslim community has started settling in the village after the separation of India and Pakistan. In last five decade a large portion of hindu families migrated to India. Specially within the period of 1947-1970. Most of those families migrated selling the property to the Muslim Community. Some families exchanged their property with the Muslim furilies willing to settle here in Herhakhal. The newly settled Muslim families are known as rewaj. A small number of Rewaji families (3.28%) are now living in the village. They have good influence over the power structure of the villages.

3.5 The Peasants of Heshakhal

The village *Heskakhal* is within an agrarian setting where a major portion of its population is peasant. Almost all of the total population are directly or indirectly dependent on agriculture. The presence of a large portion of peasant families plays a vital role in the socio-economic structure of the village.

3.6 Origin of Peasantry

The elderly people living in the village told that, the locality was a large swamp. Inhabitants living in that time mostly belonged to fisherman community. Among them only a small portion of peasant community were living. The Hindu population were depending on business and other activities. The cultivable land was not large in size, because of the presence of the swamp. Most part of the locality was low lying not favorable for agrarian activities. In course of time peasant families from south east part of *Noakhali* started settling in this part of *Noakhali*. They are locally known as *Swondupi.* About a hundred years ago the *Swondupi* peasant community started using the swamp land for cultivating paddy, specially local variety of paddy which can sustain in fresh flood water. In late thirtyies, of last country the villagers started developing the low land. In late 70s, high yielding variety of rice started growing in the village. Agriculture technology started introducing, in the village at that period of time. The peasants of the village were aware of new HYV seeds irrigation, line sewing use of fertilizer and pesticides. Road communication was not in standard form in that period.

Migration of Hindu families and the East Bengal State Acquisition and Tenancy Act enacted in 1950 played a dominant role in the evolution of peasant societies in the village. The Hindu community owned most of the cultivable land before 1950. The Muslim populations were mostly share croppers of the Hindu landowner. After the tenancy act of 1950, Muslim peasants became landowner in the village by buying land from the migrated Hindu families. Land is the major capital and asset of the peasant families. Increase of population and scarcity of land is making the asset more valuable. In the present context the villages own several disputes over the ownership of land among some families. It is also a major cause of faction grouping and conflict. In such context the peasant communities are now facing several types of problems in land operation which are discussed in the later part of the report.

3.7 Share cropping

Share cropping is an important livelihood among the peasants of *Heshakhal* village. Generally large farmers give their land to the share croppers. The system of share cropping in this part of *Nangalhot* is known as *Bhaga*, which also means share. A share cropper in the village explains the system of share cropping.

Along with the share cropping system there are other common systems in the village like renting out. One of them is locally known as poshani mortgage.

The rich farmers cultivate their land by using day labors. Share croppers in some cases use to work in rich farmer's plot. This is because they need money in the production period. Working in other land as day labour may bring some money, which he spends in his own plot.

Though paddy is not a very profitable crop, most of the peasants in the village like to cultivate paddy for food security. According to them growing rice is a very easy way of living.

In Bangladesh agriculture has traditionally formed the heart of rural livelihoods. However, this is changing fast. Nationally, agriculture was the slowest-growing sector during the 1990s and, gradually, declined in importance in the share of GDP. Despite its poor performance relative to other sectors, the agriculture sector did however still continue to grow. However, the type of growth has been different from the rice-led growth of earlier times. Crop diversification, farm mechanization (notably the expansion in the use of power tillers for land preparation) and the exploitation of new ecological, technical and economic niches (such as vegetable production and integrated fish-rice production) contributed most to economic growth in the crop sector. The livestock and fisheries sub-sectors have been particularly vibrant, despite the fact that there was a decline both in access to, and status of, common property resources, particularly aquatic and fisheries resources. However, the nature of agricultural growth has not always been labour-absorbing. This raises questions about who has benefited from agricultural growth.

The traditional image of the peasant farmer sitting at the centre of the rural economy has long disappeared from much of rural Bangladesh. The reality is that rural households are as likely to be involved in non-agricultural livelihoods as they are in farming and, increasingly, they derive incomes from multiple sources. The greatest expansion has been in the services sector. The number of small shops in villages has increased substantially, as have tailoring and other craft enterprises, rickshaw pulling and petty trading in villages and local bazaars.

In Heshakhal village, too some peasant families are trying to shift their manpower to other sectors. Nonfarm sectors like small business, rickshaw pulling, carpeting and working in urban centre are becoming important sources of income for the peasant household. But, still, agriculture activities play a dominant role in their livelihood.

4. Social Organization of the Village

For understanding a society, the behavior and characteristics of various institutions/organizations need to be studied. According to the behavior scientists the basic human social organization is marriage and family and the largest organization is the state. In Bangladesh, a village consists of several institutions. In the following sections various social organizations and changes taken place are analyzed.

4.1 Family, Household and Kinship

Family and kinship are the core of social life in Bangladesh. A family group residing in a bari would function as the basic unit of economic endeavor, landholding, and social identity. In the eyes of rural people, the chula defines the effective household—an extended family exploiting jointly held property and being fed from a jointly operated kitchen. A bari might consist of one or more such functional households, depending on the circumstances of family relationship. Married sons generally live in their parents' household during the father's lifetime. Although sons usually build separate houses for their nuclear families, they remain under their fathers' authority, and wives under their mothers-in-law's authority. The death of the father usually precipitated the separation of adult brothers into their own households. Such a split generally causes little change in the physical layout of the bari, however. Families at different stages of the cycle would display different configurations of household membership.

Patrilineal ties dominate the ideology of family life, but in practice matrilineal ties are almost as important. Married women provide especially important links between their husbands' brothers' families. Brothers and sisters often visit their brothers' households, which are in fact the households of their deceased fathers. By Islamic law, women inherited a share of their fathers' property and thus retain a claim on the often scanty fields worked by their brothers. By not exercising this claim, however, they do their brothers the important service of keeping the family lands in the patrilineal line and thus ensure themselves a warm welcome and permanent place in their brothers' homes.

Marriage is a civil contract rather than a religious sacrament in Islam, and the parties to the contract represent the interests of families rather than the direct personal interests of the prospective spouses. In Bangladesh, parents ordinarily select spouses for their children, although men frequently exercise some influence over the choice of their spouses. In middle-class urban families men negotiate their own marriages. Only in the most sophisticated elite class does a woman participate in her own marriage arrangements. Marriage generally is made between families of similar social standing, although a woman might properly marry a man of somewhat higher status. Financial standing came to outweigh family background in the late twentieth century in any case. Often a person with a good job in a Middle Eastern country was preferred over a person of highly regarded lineage.

Marriages are often preceded by extensive negotiations between the families of the prospective bride and groom. One of the functions of the marriage negotiations is to reduce any discrepancy in status through financial arrangements. The groom's family ordinarily pledges the traditional cash payment, or bride-price, part or all of which can be deferred to fall due in case of divorce initiated by the husband or in case the contract is otherwise broken. As in many Muslim countries, the cash payment system provides women some protection against the summary divorce permitted by Islam. Some families also adopt the Hindu custom of providing a dowry for the bride.

A woman being to gain respect and security in her husband's or father- in-law's household only after giving birth to a son. Mothers therefore cherish and indulge their sons, while daughters are frequently more strictly disciplined and are assigned heavy household chores from an early age. In many families the closest, most intimate, and most enduring emotional relationship is that between mother and son. The father is a more distant figure, worthy of formal respect, and the son's wife might remain a virtual stranger for a long time after marriage.

The practice of purdah (the traditional seclusion of women) varies widely according to social milieu, but even in relatively sophisticated urban circles the core of the institution, the segregation of the sexes, persists.

The segregation of the sexes extended into social groups that had rejected full purdah as a result of modern education. Although urban women could enjoy more physical freedom than was traditional and the opportunity to pursue a professional career, they moved in a different social world from their husbands and often worked at their professions in a specifically feminine milieu.

4.2 Family (Paribar) in Heshakhal

In *Heshakhal* village most families are in extended form which means few nuclear families living within a bari may or may not cook in the a hearth. In such a case, land is the basic factor to unite the members of an extended family. Another form of family found in the village is the nuclear from of family, where father, mother and children live within a hearth. These types of families are mostly seen in the village who own less cultivable land or have secondary professions.

Joint family system is the most traditional and formal family form in the peasant society of Bangladesh. Joint family means more than three generations of family members are living within the same hearth, having a family head (who generally is grandfather). These types of family were more in Heshakhal years ago.

Decision making and utilization of resource was the major feature of the joint family. But this type of family system is in a transitional form.

Among the 825 households of *Heshakhal,* more than four hundred and fifty households are in extended form. The second largest number, close to four hundred households, are in nuclear family form. There are few families living in joint form of family system.

A major research question in the field was what is the major course of changes occurring in the families. The key informant, mostly the elder ones have given the answer. The changes are as follow:

1. Decay in Family values;
2. Decrease of respect to the elder one;
3. Out migration;
4. Degradation of family unity.

Another major finding was, the role of family is now changing. Three decades ago the member of families were mostly involved in agricultural sector. But at present families are trying involve family members in non-farm activities. Out-migration is another major feature of families of Heshakhal. Though the number of out-migration is not in large form but families are trying to send their members out of village for non-farm activities. According to the peasants of the village, agriculture is not a profitable sector. But it is important for family's food security. Some families own secondary homesteads at Nangolkot Upazila.

4.3 Bari/Homestead

Bari is considered as pioneer social organization in Bangladesh villages. In common meaning bari is homestead. The name of homestead is synonymous with the family name or occupation.

In *Heshakhal* village bari is considered as an important unit of social organization. In common bari is considered as an individual's identity. A person introduces himself by his name along with his bari. Generally bari consisted general homesteads of affinal related kin groups. In *Heshakhal* village some bari owns title, which is an important factor for identifying the bari. Some bari's title is used with its genealogical identity (*Hazibari, pal bari, Miaji bari).* Some bari's title is used along with its professional activities (*Dhopa bari, Mistri bari*); So*me bari's title is used by its special characteristic (such as pagal bari,* Fakir bari). In the village there are also many baris having no title.

The role of bari in social formation in the village is very important. Status and position some time vary from bari to bari. Specially in economic activities and in marriage system bari is considered a prime issue. Professional activities also relate with the position and status of bari. Generally most of the people, though directly related with agriculture, do not directly relate with agriculture or work in the field.

4.4 Gusti/ Bangsha

Gusti or Bansha (lineage) is another important social organization in peasant society of Bangladesh. The Gosti is the basic organization related with kin group. In general, Bansha is blood related kin members generally living in a cluster of homesteads. The term Bansha originated from the term bamboo bush. The process of Bansha formation is very much similar with the growing of bamboo bush. In rural Bangladesh kinship plays a vital role in social and economic activities. Bangsha is the formal representation of kin group.

In village *Heshakhal* the original or first Gusti was the Hindu Gosti. At present *Majumder, Bhuiyan*, Vaisha Gosti are the dominated Gusti. Gosti feeling and unity is related with status and power. Those Gustis whose members own position and status in the society are considered big and powerful. The members of those Gostis identify and unite themselves with Gosti feelings. Gosti feeling is much seen among the families which are well of.

4.5 Samaj

Samaj is another important social organization among the peasant society of Bangladesh. In general the meaning of Samaj is living together. “Samaj is founded upon reciprocal relationship, common identity, and strong neighborhood generated by the proximity of residence” (Mashreque, 1985). To the villagers the meaning of ‘Samaj’ is a platform from where socio-economic activities are done as well as managing conflict within it. According to the writing of P.J. Bertocci “It is a council build up by the elder members living within it”. Samaj is the unique social organization in peasant society of Bangladesh.

In Heshakhal village the villagers use the concept of samaj in varied ways. Sometimes it represents territorial unit, sometimes it represents religious activities and sometimes this is a platform related to Gusthi activities. One major linkage of forming samaj is growth relationship. It is very often found that two rival Gustis solve their problem with an affinal relationship and transformed into a single samaj.

4.5.1 The Roles of Samaj

1. Conflict Resolution among the members of it;
2. Arranging social gathering;
3. Arranging social/cultural programmes.

In *Heshekhal* village, more than ten Samaj were found. It was observed that though the number of Samaj increased, their role has decreased. Originally in the village there were two major Samaj, the Hindu Samaj and the Muslim Samaj. The role of Samaj was much more effective then compound to the present. In course of time, belief and dependency among the Samaj members have decreased. At present the major and the only role of the Samaj is conflict resolution.

4.6 Affinal Relationship: Alliance between faction Group

Marriage system plays a vital role for establishing alliance among the conflicting Gostis. According to the fieldwork in Heshakhal village, both Gusti marriage and inter-Gosti marriage were found. In conflicting situation among the Gustis, marriage may play a vital role for establishing alliance among the Gustis. Generally the dominant Gusti wants to raise its support by establishing affinal relation with Small Gusti.

In *Heshakhal* village Miaji Gusti is one of the powerful Gustis. *Majumder* and Vaisha are other two influential Gustis. These three Samaj originated from Deshi Samaj. Miaji Samaj established affinal relation with Vaisha Samaj and *Majumder*, which was not only marriage, but also established alliance among three Deshi Samaj in the village.

The political significance of marriage, therefore, leads us to say that marriage alliance creates new groups of relatives and regulates recruitment in factions and as such affects the power structure (Mashreque; 1985).

4.7 Changes in Social Organisation in the Village

According to key informants and informal talking with the respondents in the village it was found that changes were occurring in the social organizations, viz, family, gusti, and samaj. Regarding change in family, it was found that joint families are breaking down and transforming to extended family and nuclear family. The changes in gusti are visible in that the Gusti feeling is decreasing and Gusti title is not always used among the Gusti members. Moreover, the affinal relation among the Gusti members is decreasing.

Finally the change in structure and role of Samaj is very much visible in the village. Due to the increase of households and the process of settlement of households in different para of the village, the Samaj is becoming smaller than it was forty years ago. Because strong of the presence of Union Parishad, Upazila administration and court system, people do not not fully depend on Samaj for conflict resulation. For these reasons the role of Samaj leaders is decreasing. At present many young people in the village, especially the educated ones have connection with outside power yielder. So the young ones show less respect and obedience to the Samaj leaders. Another changing role of Samaj is in its social activities. In social and religious gathering such as wedding ceremony, rituals after death, Khatna programme of the members of Samaj, the leaders used to play a strong role. But it has become more flexible how. Distrust among the members within a Samaj is a major cause of this type of change.

5. Factionalism and Power Structure

5.1 Factionalism: Context of Heshakhal

Factionalism is the basic feature of social structure of peasant society. The term "factionalism" derived from the basic word "Faction" which means grouping. In the peasant society in Banglades, faction grouping can be seen. In the decade of 1470s. American Anthropologist P.J. Bertocei identified faction grouping as a non-corporate group in the villages of Comilla (P.J. Bertooci, 1970).

A major question arises how the faction groups are formed and how they work. The research team has identified various types and features of faction grouping in Heshakhal village, which are reported below.

5.2 Power Structure of the Village

The word power is closely related with the word authority. The peasant society of Bangladesh formed a traditional type of power structure, which are: patron client relation; encapsulation and factionalism.

Patron-client relationship in peasant society is noting but the substance of founded relationship. In peasant society a significant number of members are clients who are dependent on patrons in various socio-economic factors. Among the factors land is the most vital. Along with that decision making depends on patrons in social activities. Patron is a person of power status, authority and influence (Max Weber, 1962)

In peasant society the politics among the peasants is controlled in two centers, one is the village and another is the state. State indirectly play is role by imposing law and control over land. In Bangladesh the role of state is played by the Upazila administration in the local level. Union Parisad also plays a vital role in peasant politics of Bangladesh. Along with that, in national polities the influence of localism is very much clear. The parliamentary form of govt. is such a type of system where localism is playing a vital role.

In determination of power in Heshakhal where three subgroups of Muslim communities are living, the political relation among the subgroups are shaped by informal political consideration. Education and linkage with formal institutions, specially linkage with national political party, play, a dominant role in power practice of the village. In other part of Bangladesh it is seen that power is strictly related with quits structure. But in Heshakhal it was found that relation with formal govt. institution and political parties plays dominate role in power structure of the village.

5.3 Evoluation of Power Structure in the Village

Before 1947 the major power structure was based on the Hindu traditional power elite of the village. A major change occurred during the era of 1950-70. The migration of Hindu families to India was one of the major incidents of the village. Along with that political formation in state level influenced the traditional power structure of the village. In the decade of 1950s, the Muslim middle/rich farm families became power elite of the village. The Muslim community of the village was divided in to two major fragments. The Deshi population became the dominated group because the settlements of the Deshi community were scattered in the village. The *Swondupi* community, though Shall in number, tried to enter the vacuumed power structure of the village. They developed the *Swondupi* Samaj that was united both culturally and affinally. In this period of time few Rewaji Muslim families started living in the village.

After the election of 1954 Jukta front became the most influential party of East Pakistan instead of the Muslim leauge. Muslim league was supported by the rural urban rich class. In Jukta front the leadership was from the middle class Muslim. The rural peasants used to support the party. The era of Ayub khan changed a lot in the local and national level politics. General Ayub khan introduced a special type of democracy which was known as basic democracy. In this system of democracy people cannot vote directly to nominate their representative in the parliament or the presidency. Instead of that they voted to select the local representatives. These local representatives were known as basic democrats. The basic democrats would select the president. The system of basic democracies consisted of four tiers. The first was the organization for villages. In rural areas, a number of villages grouped together to constitute a union. A union council was set up for it. The second tier is thana council. Third one is district council, fourth one is divisional council.

The basic democracy system for the first time directly involved the rural power class with the state level political process. Before 1950 the peasant farm families of East Bangal were indirect tenants of the Government. They were direct tenants of Zamindars of East Pakistan. The Land reform law in 1950 established the process of their becoming direct tenants of the Government. The basic democracy system influenced the power structure of Heshakhal village. Union Board was another important platform for exercising power in the village. The chairman was nominated by the people. Along with that, traditional Samaj structure was much strong to reform its activities.

5.4 Historical Context of Factionalism in Heshakhal Village

Before 1947 Heshakhal village was dominated by the Hindu population. The Hindu social leaders used to play dominant role in socio-cultural activities in the village. The Union Board of Nongalkot was dominated by Hindu leaders. No political party was active that at time. When any dispute arose within the village the Samaj leaders used to solve it. Before 1947 there was a distinct difference in two groups of Muslim population. The Deshi inhabitants were not socially or afinally related then with the Swandupi population. Economically the Swondupi people were less advanced than the deshi. Another factor was that their language and way of life was not adjustable with the deshi population. Very few Swondupi family could establish marital relation with the deshi inhabitants of Heshakhal village.

After the separation of Indian subcontinent a major change occurred in the village Heshakhal. Most of the rich and influential Hindu families migrated to India. Some families exchanged their assets with the Muslim families of Agartala that were willing to settle in Heshakhal village. These new Muslim families in the village are known as Rewaji family. In 1950 Govt. abolished the zemidari system. The tenants became direct tenant of government.

In earlier 1960s, the basic issue of factionalism in the village was ownership control over land. Like in other peasant society, land is the most important asset of farm families. In Heshakhal village the same scenario was seen. Along with that most of the landowner Hindu families migrated to India without settling their asset specially land. They left East Pakistan out of fear or security threat. Few families was able to sell their land and did not provide full document/papers to its Muslim owner. A few Muslim families from Agartala also exchanged their property with a few Hindu families of Heskakhal. In late 1960s faction grouping arose on the basis of control over the land left by the Hindu families. The then Muslim community became segmented in to three subgroups, deshi, Swondupi and Rewaji.

The major issue of faction grouping among the segmented groups was also control over own group members, especially in the election process of local govt/UP election. A member in the UP can provide a group enough support solving conflict in local level. The members also work in Salish process in the village. They maintain good relation with the government officials. That's why each segmented subgroup tries to support their own member in voting. Even in M.P. election if a subgroup supports one candidate the other supports another.

In Salish system, the leaders of subgroups try to play their role. But if the conflict arises in the same Samaj, the elder member tries to solve it without the help of the elder members of other Samaj.

Faction grouping plays its role in various committee of formal institution within the village. It is deeply seen in the Bazar committee, school committee, and even in various social programmes.

5.5 Major Events in Political change and faction grouping in Heshakhal

1947-60

Influential and landowner Hindu families migrated to India. The Rewaji families started settling in the Heshakhal village. Land reform act was passed and the inhabitants of the village became the direct tenant of government. Union board was transformed as Union council.

1960-70

Basic democracy was introduced in the state level, which influenced the power structure of the village. Ayub Khan brought a dimensional change among the Muslim faction group in Union council election and selection of basic democrats.

1971-1975

The war of independence influenced the inhabitants of the village. Some young members took part as freedom fighters. They were in support of Bangladesh. Some opportunist traditional leaders were in favors of Pakistan.

After independence of Bangladesh a new and young power group rose in the village. Part of these power elite were Swondupi community. But the *Deshi* community leader took advantage as they had good relation with the local govt. In 1973 Union Parsad replaced union council.

1976-1990

Many development initiatives were taken in this period. Communication facility developed. In political arena of the village, the Rewaji families started involving in with the *deshi* community. They became advanced in education sector and in out migration.

In 1978-80 President Ziar Rahman introduced Gram Sarkar system. The village power got their link with the state level political formation.

Four national level elections were held in this period of time. The most significant change was decentralization of local govt. Nangolkot became a separate *upazila* in 1884.Upazila election was held in 1985, which directly related the local power group with the upazila level. The power elite started to relate themselves with upazila administration, specially the court. According to the elder members in the village, the role of Samaj decreased due to the presence of upazila headquarter five kms close to the village. Inhabitants started to depend on court instead of the traditional *Salish* system.

The peasant community was dependent on BADC for seeds and other agricultural support. At the end of 1980s the dependency had transferred to nongovernmental sector specially to the dealers. In this period of time farmers started producing HYV crops specially HYV paddy.

1990- Present

In state level a change occurred. Parliamentary form of government system was introduced. The system involved the traditional power structure with the national level political parties, because the members of parliament now became more influential than in any other time. Though their main role is to make laws in practice they became the centre of the power structure of their constituency. The local power yielder was becoming more close to the central political system. The same scenario was found in the studied village. A portion of power elite supported Awami League. Most of the supportes of Awami league were Deshi inhabitants of the village. On the contrary, the Swandupi inhabitants supported B.N.P. But not all were directly involved with politics. Most of the inhabitants supported one of the other party as they had to support someone in the M.P election. If one faction group supported one party, group supported the other. In 2002 the village along with some areas of Addra union became a new union, which was named as the Heshakhal Union. The Gram Sarkar system was reintroduced by the B.N.P govt.

After the election of 2001 the influence of local M.P became very much dominant even in the local faction grouping in the village. Young members in the village started became leaders of local student front. In this period of time Jamate Islami Bangladesh became one of the dominant parties in Nangolkot region.

For the vast majority of Bangladeshis, politics revolves around the institutions of the village or the union of neighboring villages. Traditionally, the main base for political influence in rural areas has been landownership. During the British colonial period, zamindars controlled huge estates as if they were their personal kingdoms. With the abolition of zamindar tenure in 1950, a new local elite of rich Muslim peasants developed. The members of the new elite owned far less land than the zamindars had once possessed, but they were able to feed their families well, sell surplus produce, send their children to school, and form new links with the bureaucracy of East Pakistan and later Bangladesh. Amid the large majority of poor and generally illiterate peasants, well-to-do farmers formed a new rural leadership that dominated local affairs.

Village society is often divided into a number of factions that follow the lines of kinship. At the center of each faction is a family that owns more land than most of the other villagers. In the colonial and Pakistani periods, local leaders were old men, but the trend since independence is for younger men to head factions. The heart of the local elder's authority is his control over land and the ability to provide land or employment to poorer villagers, who are often his kin. Land control may be an ancient prerogative, stretching back to the zamindars, or it may be the result of gradual purchases since independence. A village may have only one faction, but typically there will be several factions within the village, each competing for influence over villagers and struggling for resources from local administrative and development offices.

The leaders of local factions exercise their influence in village courts and as managers of village affairs with other administrative units. The traditional means for resolving local disputes is through the village court, which comprises leaders of village factions and other members of union councils. Throughout Bangladesh, village courts address the vast majority of disputes, but it is rare for the courts to decide in favor of a poor peasant over a rich peasant, or for the weaker faction over the stronger. The relative security of village leaders makes it possible for some of their children to attend secondary schools, or even colleges or universities; some factions also base much of their authority on their knowledge of sharia. Education is much esteemed in Bangladesh, and degrees are tickets to highly prized government positions or to urban jobs that give the involved families a cosmopolitan outlook. These contacts outside the village include necessary links with bureaucratic institutions that ultimately bring economic aid and patronage jobs to the village. In these ways, the factional leadership of the village provides vital links to the development process, while retaining its traditional position at the top of village society.

Local leaders who control land, people, and education also tend to control the disbursement of rural credit and development funds through their positions in union and subdistrict government. Studies of the leadership of union council members have demonstrated this dominance of local elites over rural political and economic life.

6. Conclusion and Remarks

This study has sought to enquire into the nature of village social organization, faction grouping and power structure related to peasant way of life. The major focus of the study was to identify the changes occurring in the social organization of peasant way of life as well as the influence of modern formal institution over the traditional institution of the village. It was found in the study that due to influence of modernization, education, influence of modern technology, state policy as well as influence of external formal institution the peasant social structure is changing rapidly.

The social organizations remaining in the village are in transitional form. In traditional peasant society joint family was ideal for land operation and handling the natural resources. It was found in the village that the Joint families are transformed into extended family or into nuclear family. The families that own less land transform to the nuclear family system. Those families who own much land transform to extended family system. Non farm activities among the family members are increasing day by day.

There is a major change in the *Gusti* structure and in Samaj system. Gusti is still playing vital role in faction grouping but there are how enough families who do not depend on *Gusti* . Many families in the village do not use *Gusti* title. Their relation with their kin group is flexible. The role of Samaj has changed in the last 30 years. Before that the major role of Samaj was arranging *salish* and social activities. At present Samaj has broken to several *Samaj*. The relationship within the *Samaj* structure now is just like between patron and client. The role of union parisad members has been increasing. They are playing role in conflict management and in connection with government institutions.

The leaders of local factions exercise their influence in village courts as managers of village affairs with other administrative units. The traditional means for resolving local disputes is through the village court, which comprises leaders of village factions and other members of union councils. Throughout Bangladesh, village courts address the vast majority of disputes, but it is rare for the courts to decide in favor of a poor peasant over a rich peasant, or for the weaker faction over the stronger. The relative security of village leaders makes it possible for some of their children to attend secondary schools, or even colleges or universities; some factions also base much of their authority on their knowledge of sharia. Education is much esteemed in Bangladesh, and degrees are tickets to highly prized government positions or to urban jobs that give the involved families a cosmopolitan outlook. These contacts outside the village include necessary links with bureaucratic institutions that ultimately bring economic aid and patronage jobs to the village. In these ways, the factional leadership of the village provides vital links to the development process, while retaining its traditional position at the top of village society.

References

1. Abdullah, A (1980) 'The Peasant Economy in Transition: The Rise of Rich Peasants in Permanently Settled Bengal', *The BangladeshDevelopment Studies*, Vol.VIII, No.4, BIDS, Dacca.
2. Arens, Jennek and Jos Van Beurden (1977) Jhagrapur: *Poor Peasants and Women in a Village in Bangladesh*, Birmingham: Third World Publications.
3. Bertocci, Peter J. (1970) *Elusive Village, Social Structure and Community Organization in Rural East Pakistan*, Ph.D. Dissertation (Mimeo)U.S.A. Michigan state University.
4. Chowdhury, Anwarrullah (1978)" A Bangladesh Village: A Study of Social Stratifications," Centre for Social Studies, Dhaka University.
5. Mukherjee, R.K. (1957) *The Dynamics of Rural Society*, Akademic Verlay,Berlin.
6. Mashreque, Shairul, (1985)," Kinship And Power Structure In Rural Bangladesh: A Case Study," Chittagong.
7. Weber,Max(1962), *An Intellectual Portrait*,University Puperback, London
8. Wolf, Eric R. (1966) *Peasants,* Prentice-Hall, Englewood Cliffs, New Jersey. USA
9. Zaidi, Hafez S.M. (1970)" The Village Culture in Transition: A Study of East Pakistan Rural Society," East-West Center, Honolulu.USA

Glossary

Appendix

Local area measures

Decimal	Area measure, 100 decimal =1 acre, 247 decimal= 1 kaeter
Gonda	Six decimals of land constitute a Gonda (0.06 acres)
Kani	Twenty Gonda constitute a Kani (1.2 acres)

Bengali month

Baishak	Mid April to mid May
Jaistha	Mid May to mid June
Ashar	Mid June to mid July
Sraban	Mid July to mid August
Vadra	Mid August to mid September
Aswin	Mid September to mid October
Katric	Mid October to mid November
Aghrahayan	Mid November to mid December
Poush	Mid December to mid January
Magh	Mid January to mid February
Falgun	Mid February to mid March
Chatre	Mid March to mid April

Other Local Term

Aman Paddy	The seasonal rice crop grown in the late summer and fall.
Aus Paddy	The seasonal rice crop grown in the spring and early summer
Krishak	Peasant
Mohajan	Traditional money lender
Bebsha	Business
Bari	Lineage where descendants live together
Bhagha	Sharecropping
Chakri	Service
Chula	Cooking Hearth
Gusti	Lineage group
Masjid	Mosque

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 353-367
Bangladesh Economic Association
(ISSN 2227-3182)

Problems and Prospects of Poultry Industry in Bangladesh

MUHAMMAD MAHBOOB ALI*
MD. MOULUDE HOSSAIN**

Abstract *The poultry industry is how gowing successfully and becoming a leading industry of Bangladesh. The primary objective of the study is to identify various aspects of the growth and sustainability of poultry industry in Bangladesh. Authors argue that strategic management in poultry sector should complement government efforts to achieve the Vision 21 objestivec. This industry can provide various opportunities to increase GDP growth rate plus equitable distribution through arranging food security as well as ensuring self employment, creating purchasing power and reducing poverty at a large scale. One importance should be gaven to the country's poultry industry in order to ensure its confinued development as will as to save the small and medium farmers. Authors observe that for importing poultry related products huge amount of valuable foreign exchange is spent. They propose for providing subsidy to the local industry to safeguard the interst local entrepreneurs Vaccine, vaccinations services, alternative to vaccine services, antibiotic feed additives and other inputs and services of the poultry sector should be developed locally as suggested by the authors.*

Keywords: *Poultry, GDP, Poverty, Bangladesh*

Introduction

Bangladesh is one of the high density countries of the world with a population of 150 million people within the area of 143,000 km^2. About 80 percent people of

* The first author is Professor and Head, M.H. School of Business, Presidency University.
** The second author is lecturer, School of Business, Institute of Science and Technology under national University.

this country still live in villages and are extremely poor. Both the government and a variety of non-governmental organisations (NGO's) are actively promoting poultry development at all levels. The Bangladesh Rural Advancement Committee (BRAC) shows in its' annual report that more than 70% of rural households are involved in poultry keeping. But they face serious constraints, as the mortality rate of poultry is said to be as high as 25%, due to a combination of improper feeding practices, ignorance of management needs and poor distribution of vaccines. Poultry sector will create job opportunity for 10 million people as claimed by poultry leaders in a round table titled "Present Crisis and Prospects of Poultry Industry in Bangladesh "(Source: Financial Express, Bangladesh 23 July, 2010).

Small-scale poultry production has developed in a large number of developing countries around the world as an important source of earning for the rural poor. In the last few years, the recognition of small-scale commercial poultry production helped to accelerate the pace of poverty reduction riding in new height in Bangladesh. The poultry industry has been successfully becoming a leading industry of the country. The sector started farming during mid sixtiesat and has growth rapidly an annual rats of around 20 per cent during the last two decades. This industry has immense potentialities from the point of view of the countrys economic growth of the country as well as fulfillment of basic needs and to keep the price at a minimum level and ensure food especially animal protein for the people. The current farming structures of poultry in the country are of two types one in the conventional countryside backyard or scavenging/semi-scavenging system while the other is a business-related farming system. Conventional poultry production is an essential part of rural farm household activities; a few birds are reared with little or no feed complement to generate eggs and meat for home consumption and any excess is sold. Business related poultry farms raieing birds of high yielding breeds as a profit oble business exercises. But the recentl declining trend in the poultry industry has been creating a problem for the country.

This industry holds immense promise for the country. It can change livelihood and food habit, ii) reduce dependence on cow and goat meat positively. Contribnts to the countrys GDP growth.

The poultry industry has been making progress despite: i) Avian Influenza/bird flu outbreak; ii) price rises of raw materials in the international market; iii) Lack of infrastructural support

This research study secks to assess the impact of the poultry industry on the people of the country.

Literature Review

Gopalkrishnan and Mohanlal (1994) argue that food costs represent 65 to 75 per cent of total cost of commercial policy production, depending mainly in the relative costs of feed constituents ,labour, housing., miscellaneous items of costs in a particular situation. Therefore it becomes imperative that economic as well as nutritionally balanced diets are provided during all phases of productive life-in eggers, chickens, grower and layer stages and in broiler, starter and finishing stages. The economics of poultry feeding depends to large extent on the local situation of food availability and competition for the same foodstuff for use by human beings.

Hunton (2001) in a study says that there is no doubt that exciting times lie ahead for the Bangladesh poultry industry. The combination of basic low input-low output, subsistence level growers, and all combinations up to and including large scale commercial production, present a daunting and stimulating prospect to a government preoccupied with poverty and malnutrition. Nevertheless, the poultry industry represents one way of accomplishing several national goals under a single banner. Employment, poverty alleviation and improved nutrition are all potential benefits from continued support and encouragement of poultry development.

Islam(2003) comments that the poultry sub-sector is crucially important in the context of agricultural growth and improvement of diets of people in Bangladesh. The sub-sector is particularly important in that it is a significant source of the supply of protein and nutrition in a household's nutritional intake. It is an attractive economic activity as well, especially to women and poor population.

Banerjee(2004) observes that in comparison to other livestock , poultry requires less investment to start the farming. Persons from low income group may also start the business on a small scale. Poultry farming offer opportunities for full or part –time employment particularly women, children or elderly person on the farm. Khan , Miah , Bhuiyan , Begum , Hussain and Khanum (2006) observe that Local chickens dominate poultry production in Bangladesh. In Sylhet mainly poor families, who have arrived from outside and are landless rear poultry. Most of the households (58.33%) had 0-15 chicken. Most of the families (75%) reared their chicken combined with duck. Materials used were similar to other parts of the country. Mainly female members were involved in poultry rearing. About fifty percent farmers got on an average less than 70 eggs per year per bird. A few farmers (5.56%) informed that they had collected more than 130 eggs from a bird in a year. In most of the cases (47.22%) the length of clutch was less than 20.

Interval between two clutches was found in the highest percentage of farmers (42.22%). Highest egg production was observed in winter season (52.78%) followed by summer, spring and late autumn. Maximum (60%) farmer had vaccinated their birds and 55% farmers got service from Department of Livestock Services.

Jabbar et al.(access on 31 December ,2007) comments that since the early 1990s, contract farming as a market institution in the poultry industry in Bangladesh has evolved along with the expansion of commercial poultry farming. Apart from classical contract farming within vertically integrated enterprises, there are also formal and informal contract arrangements in input marketing and output marketing A high drop-out rate among commercial poultry producers is observed. Results of a survey conducted among farmers who dropped out of the poultry business in recent years are presented, highlighting the causes of dropping out and the possible role of contract farming in addressing them.

Akter and Uddin (2009) argue that as an important sub-sector of livestock production, the poultry industry in Bangladesh plays a vital role in economic growth and simultaneously creates numerous employment opportunities. The poultry industry, as a fundamental part of animal production, is committed to supply the nation with a cheap source of good quality nutritious animal protein in terms of meat and eggs.

Aho (2010) predicts that the output poultry meat may fall before that of eggs in the world production. The factors that influence the production of poultry meat and eggs, he said, are real income per capita, the distribution of income, the cost of grain and the size of the human population. “Poultry will do well despite higher grain costs,” said Dr Aho. This is because, at around 2:1, feed efficiency is better for poultry meat than pork (3:1) or beef (4:1), largely thanks to the tremendous progress made by broiler genetics companies over the last 50 years or so. Another important factor is the difference in water requirement: 3,000 litres for chicken compared to 6,000 litres for pork and 16,000 litres for beef.

Bangladesh Food Security Investment Forum Report (May 2010) states that the vibrant fisheries sector in Bangladesh accounts for roughly 20 percent of the agricultural GDP while the growing livestock sector comprises around 12 percent. More than 10 million Bangladeshis directly depend on these sectors for their livelihood. A large proportion of these people are smallholders whose production of milk, meat, and eggs increased significantly between 2002 and 2008 primarily because of improved breed, feed, and fodder; available veterinary health services; and investments led by the private sector. The growth rate in the fisheries sector has also improved—from 2.33 percent in 2002?03 to 4.11 percent in 2007?08. This growth is largely from intensive technological management practices in agriculture. Pond aquaculture has also been improving and now produces about 866,049 metric tons (mt) per year, representing 41.92 percent of total inland fish production (2,839 kilograms/ hectare).

Shamsuddoha (2010) observes that sustainable development of environment friendly commercial poultry industry in Bangladesh seems to have attracted little attention.

According to http://www.thepoultrysite.com/articles/943/antibiotic-feed-additives-politics-and-science Cervantes commented that contrary to public perception, the continued use of antibiotic feed additives is beneficial for both, animal and human health (accessed on 5th November,2011).He said that there are numerous scientifically documented benefits derived directly from their use, such as the prevention and control of enteric diseases, enhanced food safety, improved animal welfare, preservation and less contamination of the environment, improved efficiency of production and lower cost of production resulting in lower prices for the consumers who can continue to enjoy an abundant supply of safe and nutritious food products of animal origin at an affordable price.

According to http://www.fao.org/ag/againfo/themes/en/ infpd/econf_ bang.html (accessed on 5th November, 2011) small poultry enterprises with adequate institutional support targeting the poorest rural women and their families can help them take the first step out of poverty. However, for the concept to work as a poverty breaking tool (i) the beneficiaries must come from the poorest segments of the village, (ii) the cost of producing an egg must be lower than in the commercial sector, (iii) an enabling environment must be established to keep a small flock of hens, inter alia, access in the village to feed, vaccine, vaccinations services, micro-finance, marketing and other inputs and services, and (iv) the enabling environment must contain institutional and political space to provide the people involved the possibilities and opportunities to take the next step out of poverty.

Objectives of the Study

The primary objective of the study is to identify the various aspects relating to the growth and sustainability of poultry industry in Bangladesh. Secondary objectives of the study as follows:

- To identify the market structure various stakeholders and market players in the poultry industry of Bangladesh.

- To identify the factors that affect competitive advantage, profitability and growth potential poultry production.
- To determine the impact of the poultry industry on the food supply chain of Bangladesh.
- To address risks associated with the poultry industry and recommend meansres to mitigate those risks for the sustainable growth and development of the industry.

Making Vision 2021 a Reality: Prospects of Poultry Industry

According to OUTLINE PERSPECTIVE PLAN OF BANGLADESH, 2010-2021: MAKING VISION 2021 A REALITY, poor nutrition presents a major health problem. It is evident that a substantial majority of the population suffer from varying degrees of malnutrition, including protein-energy malnutrition, micro-nutrient deficiencies (such as vitamin A deficiencies, calcium deficiency disorders), iodine deficiency disorder, iron deficiency and iron deficiency anaemia, and vitamin deficiencies. Poultry sector in this regard has been playing a significant role in providing protein at a lower cost. Most probably it is the only sector that can grow vertically and produce maximum amount of egg and chicken using the minimum land.

Poultry Industry: contribution to rural & national economy

- Livestock plays an important role in the national economy, contributing significantly to agriculture and the gross national product.
- 44% of human daily intake of animal protein comes from livestock products.
- Furthermore, it plays a pivotal role in the rural socio economic system as maximum households are directly involved in livestock.
- Investment in poultry sector should be doubled within the next decade and it will enhance the growth of this sector and contribute to the GDP and creates employment opportunity.
- In the nineties total investment in this sector was only Tk 15 hundred crores, but now it is more than Tk 15 thousand crores
- It has created job opportunity for more than 60 lakh people.
- The poultry industry has been suppling quality protein to the Bangladesh population at the lowest price in the world.

Present situation of the Poultry industry has been shown in Table- 1.

Table 1:

	June 2010	December 2010	March 2011
Production of Bird (Million Kg./day)	1.95	1.70	1.6
Egg production (Million /day)	27.5	26	23.5
Number of Poultry farms	1,14,000	98,000	75,000

Source: *Chowdhury, 2011*

From the aforesaid table: 2, we are seeing that declining trend of production is prevailing in the poultry industry of Bangladesh.

Moreover, of the price poultry feed has also been rising Continuously. Poultry industry is not treated as an SME. Commercial banks are not interested to finance this sector as they think it as a risky sector.

Poultry Industry: Supply of Animal Protein, Food Security

- Rising population, moderate growth of per capita income and higher income elasticity of demand for poulty products are likely to bring a further increase in the demand for these products.
- The demand for milk and eggs has increased by 6, 5.2, per cent, respectively, which is well above the national average.
- Bangladesh is a densely populated country. Agricultural land is shrinking and is reducing at a rate of 1 percent per annum. As such scarcity of production of agricultural product will be felt.
- Fish and cattle production are decreasing. These also require longer time to produce. But poultry production is relatively easier if both public and private sector initiatives go side by side.
- Poor nutrition creates a major health problem. It is evident that a substantial majority of the population suffer from varying degrees of malnutrition, including protein-energy malnutrition, micro-nutrient deficiencies, iodine deficiency disorder, Iron deficiency and iron deficiency anaemia, and vitamin deficiencies.
- Poultry sector in this regard has been playing a significant role in providing protein at a lower cost. Most probably it is the only sector that can grow vertically and produce maximum amount of egg and chicken using minimum land.

- A report titled 'Climate Change as a Security Risk' said that the probable loss of arable and residential lands through flooding in this part of the world (Bangladesh and its neighbourhood) would result in increase of internal and external environmental migration and strained relations between countries. A solution to the issue of farmland depletion could be the formulation of a sensible and realistic land-use policy.
- Moreover, from the poultry sector biogas plant and organic fertilizer can be prepared.

State of protein deficiency and contribution of Poultry Industry

- According to FAO each person should take
- 56 Kg. meat and 365 eggs per annum. But in Bangladesh per head use of meat is only 14.57 kg per annum while the use of egg is an 31 per head per annum.
- The a results is malnutrition and the rise in disparity between poorer and richer section of the society.
- Currently as per UNICEF report total population is 16.40 crore. If rises at the rate of 1.40 % per annum, protein deficiency will aggravats which can be mitigated by the poultry sector.
- The milk, which is a traditional protein food for growing children and other vulnerable population, is getting costlier and there is every chance of adultering in it.
- In future, one can visualize the egg and poultry meat not only as a supplementary protein food but also as a substitute of other meat products and even milk for a healthy purpose.

Poultry Industry: Creating Huge Job Opportunity

The sector can gereate huge job opportunity.

Poultry farming offers opportunities for full-time or part–time employment, particularly for women, children or elderly persons.

Major Challenges Facing Poultry Industry

"Yesterday who was a solvent farmer has become a poor guy today"- this is basically true to the poultry farmers. The farmers are severely suffering from security of their farms and investment. Every year thousands of farms are collapsing due to bird flu outbreak and many for their inability to buy high priced poultry ingredients and absorb losses from the fall in market price. However, the poultry industry of Bangladesh currently faces the following challenges against its growth potentials.

General Challenges

- In the country the epidemic of some types coupled with the increase in feed cost emerge to be the most significant hindrarse to this industry.
- Recently NBR is trying to impose new taxes on maize import. This has created problem as maize is the key ingredient to prepare poultry feed.
- The price of poultry raw materials has rise sharply in the international market, Which has reonlted inthe rise in production costs.
- The banks, interest rate in this sector is very high which is on average 12-14% per annum and real effective interest rate is around 18-20% per annum. Moreover, lot of hidden charges and costs by this sector to avail loans from the banking sector. Actually bank interest rate should be 10%. Moreover, NGOs and also Grameen bank should play more active role to lower the interest rate for poultry sector under their social business program.
- Both cost push inflation and demand pull inflation are presently prevailing in the country. As a result purchasing powers of the people are declining.
- This sector faces the problem of load shedding.

Avian Influenza outbreak: A threat for poultry growth

- The country is offer affected by Avian Influenza which causes huge losses for the producers bit they suldont get any sort of financial help to mitigate thers losses
- As per FAO report (20 April, 2011), Bangladesh and five ohter countries, India, China, Egypt, Indonesia and Vietnam are suffering from the H5N1 virus. This is due largely to ‘weak producer and service associations’ to support farmers. In these countries avian flu is still endemic due to poor veterinary and livestock production services. Due to bird flu we can not export chicken Nepal and also Middle East countries.
- In this context, expansion of veterinary services including vaccination is essential.
- Long-term planning and its effective implementation is heeded to feed the population of the country as well as export abroad.

Currently eggs and chickens are distributed through middlemen, As a result:

- The farmers are not getting actual price. Producers huge losses, as the production cost is high but they have to sell to the midlemen at how prices.
- The actual producers do not get any benefit of the high price as they are oppressed by the middle men who suck the profit.

- Lack of modern management of poultry farming is also creating negative impact.
- Moreover, the end users i.e. customers have to pay higher price.

Conclusion and Recommendations

Strategic management in poultry sector requires complementing government effor to active the vision-21 objictives. biscuits or detergent powders faced serious problem during early nineties. As such, special measures are required by the government to present the sictor. Price of meat of chicken and egg should be stable so that lower income group and middle income group of people can afford.

Acceptance of the most recent technology in poultry sector especially to control environment and process of automation are being required. Capacity building will add creation of value. Efficiency in production should be achiened through cost-cutting technique and reducing heavy dependence on high-cost imported raw materials for this sector. Alternative arrangement should be developed domestically for cheap feeding cost as well as air cleaning mechanism. Local craftsmen could be trained to produce tiny equipment, like feeders, drinkers, etc. Vaccine, vaccinations programs, and other inputs and programs of the poultry sector should be available for which research and development program may be taken and local pharmaceuticals should also develop vaccines and other related medicine to keep poultry sector disinfected. Environment of the farm area must be cleaned to protect them.

Arrangement for training through lives stock agencies, NGOs and private agencies are necessary for farmers and labours associated in this sector as well as extension level which may include: sickness management, accommodation and tools and promotional activities. Essential information in precise kind of poultry grounding and composition are also vital. Accommodation and organization might be enhanced through arranging suitable farmer guidance to run the farm smoothly. If Bird flu can be removed we can be able to export meat and eggs in foreign countries for which special strategy will required.

Considering the importance of the country's poultry industry in the context of agricultural growth and improvement of diets of people in the country, the development of poultry industry would surely help government to mitigate the problems of food crisis of the country. Price of chicken and egg should be kept stable and problem of middlemen should be should through arranging effective and efficient supply chain management by government. as well as Private sector, keeping in mind about the issues of customers' protection and reducing economic disparity. Bangladesh Food Security Investment Forum Report (May 2010) should be considered as an important factor to develop the poultry industry and people enabl to get access to protein related food.

Following recommendations may be considered to sustain the poultry industry of the country:

- To mitigate food deficit especially protein related food, the poultry sector needs special attention for which public and private collaboration is essential.
- To fulfill the dream of the government Vision 2021, poultry sector can act as an auxiliary force by arranging food at cheaper rate. As such, tax exemption can be extended for the period of 2025.
- Imposition of tax on import of maize ought to be withdrawn pravide relief to producers of the poultry sector specially small farmers. The industry should be considered as a thrust scotor.
- Bank loan in the poultry sector should be arranged at a 5-7% simple interest rate, considering it a thrust sector. Conditions of loan should be eased. Moreover, Bank should come forward so that new entrepreneurs as well as NRBs can come forward to invest in this sector through opening special window in each bank arranging not only bank loan but also offering special services starting from pure line farms and Hatcheries to Consumers. Banks who are net interested to invest in the poultry sector may be penalized by the Bangladesh Bank. This industry should also be brought under SME sector.
- Livestock department should be more effective and efficient. Proper human resource management and staffing as well as extension of the livestock office is required. They should play a proactive role. Livestock institutes at Sylhet and Gaibandhya should be effective and regional research centers should be more active.
- Supply chain management should be improved so that the poultry farmers can directly supply to the retail shops and middle men can not suck the profit.
- Avian Influenza affected farms should get subsidy immediately after culling.
- A special fund may be created by the government to help actual producers.
- Poultry Insurance should be introduced immediately. Insurance companies should come forward with such policies.
- Electricity arrangement is required for the poultry farms. The government may come forward to produce bio-electricity or support the poultry farmers to produce it.
- Govt. Hatcheries should be reactivated and play due role so that they can meet the huge deficit of protein related food.

- Transportation costs and facilities for eggs and chicken and chicken related products should be kept minimal so that consumers can purchase at a reasonable price.
- Govt. should come forward to deal with the problem of Avian Influenza as FAO reported that Bangladesh is one of the Sixth worst victim nations. To raise export of chicken related products abroad we need to come out from this disease.
- The farmers are laudable and that could export poultry products to foreign markets if a capacity building as will as strategic alliance among private sector, govt., Bangladeshi embassies and NRB were developed.
- Poultry industry needs special attention from the government. as this sector will not only mitigate huge deficit of protein related food at a cheaper cost but also can create employment of 1 crore people in this sector by the year 2021 as projected by this researcher, which will complement governments Commitment to create employment.
- Government needs prior planning and preparation for preventing bird flu and should arrange appropriate steps so that farmers can maintain bio-security and keep healthy environment inside and outside the farms.
- Department of Livestock should come forward with a holistic approach for developing the poultry sector. Organogram of Livestock may be restructured and it should set up office at the union level. Efficient and dynamic personalities should be appointed. They must not fix maximum price of one-day chick as it is unjustified.
- To mitigate deficiency of veterinary doctors, four year diploma courses after SSC level may be introduced. Courses may also be introduced so that technicians can be available to mitigate immediate shortage of nursing of the poultry industry.
- AIT on maize import should be withdrawn and tax imposed on pelleted feed production.
- Strong measures should be taken so that the guideline of the World Organization of Animal Health (OIE) is followed strictly while importing One-day old chick, hen or egg.
- The import of products from outside the country costs huge amount of valuable foreign exchange. As such subsidy should be given to the local industry and to safeguard the interst of local entrepreneurs. Vaccine, vaccinations services, alternative to vaccine services, antibiotic feed additives and other inputs and services of the poultry sector should be developed locally.

References

1. Aho Paul (2010). "Challenges Facing the World's Poultry Industry", http://www.thepoultrysite.com/articles/1700/challenges-facing-the-worlds-poultry-industry
2. Ahuja, Vinod and Arindam Sen, "Scope and space for small-scale poultry production in developing countries", Indian Institute of Management, Ahmedabad, India, http://www.fao.org/ag/againfo/home/events/bangkok 2007/docs/ part3/3_3.pdf
3. Jabbar, Mohammad A., Md. Habibur Rahman, R.K. Talukder and S.K. Raha, "Formal and informal contract farming in poultry in Bangladesh", International Livestock Research Institute, http://www.fao.org/ag/againfo/ home/events/ bangkok2007/docs/part3/3_6.pdf
4. Ahmed, F. (2008). Export Strategy of Bangladesh. Power Point presentation prepared for the NDC Course, 22 May, 2008. Ministry of Commerce, Government of the People's Republic of Bangladesh: http://www.mincom.gov.bd/images/additional_images/NDC-%20Export%20Strategy-22- 5-08-final.ppt (July 18, 2008)
5. Akter, Afia and Uddin, Salah (2009)."Bangladesh Poultry Industry*", Journal of Business and technology* (Dhaka), Vol.4, No.2, July-December, pp.97-112.
6. Akter, S., and Farrington, J. (2008). "Poverty Transition through Targeted Programme: The Case of Bangladesh Poultry Model." Paper presented at the 82nd Annual Conference of the Agricultural Economics Society. Royal Agricultural College. UK. http://ageconsearch. umn.edu/bitstream/36765/ 2/Akter_farrington.pdf (July 8, 2008).
7. Alam, J. (1997). "Impact of smallholder livestock development project in some selected areas of rural Bangladesh." *Livestock Research for Rural Developmen*t, vol. 9, no. 3: http://www.cipav.org.co/lrrd/lrrd9/3/bang 932.htm (June 20, 2008).
8. Alam, J. (2008*). Studies on Agriculture and Rural Development*. Palok Publishers, Bangladesh.
9. Alam, J., Akteruzzaman, Md., Rahman, S.M.A and Palash, Md. S. (2008). "Impact of Recent Outbreak of Avian Influenza on Production, Marketing and Consumption of Poultry Meat and Eggs in Bangladesh." Final Draft. Bangladesh Livestock Research Institute and Bangladesh Agricultural University.
10. Banerjee,G.C.(2004). *Poultry*, Oxford & ONH Publishing Co. Pvt. Ltd., New Delhi, 3rd Edition

11. Begum, I. A. (2005). "An Assessment of Vertically Integrated Contract Poultry Farming: A Case Study in Bangladesh." *International Journal of Poultry Science*, vol. 4 (3): 167-176: http://www.pjbs.org/ijps/fin332.pdf (July 2, 2008).

12. Bessei, W. (1990). "Lessons from field experience on the development of poultry production." In: S. Mack (ed.) (1990) *Strategies for sustainable animal agriculture in developing countries*. FAO Animal Production and Health Paper no. 107: http://www.fao.org/docrep/004/t0582e/T0582E25.htm (July 10, 2008).

13. Bhuiyan, A.K.F.H., Bhuiyan, M.S.A. and Deb, G.K. (2005). "Indigenous Chicken Genetic Resources in Bangladesh: Current Status and Future Outlook." In: S. Galan and J. Boyazoglu (eds.) *Animal Genetic Resources Information*, issue no. 35, FAO: http://www.fao.org/docrep/008/a0070t/a0070t0c.htm (July 9, 2008).

14. Biswas, P.K., Uddin, G.M.N., Barua, H., Roy, D., Ahad, A. and Debnath, N.C. (2008). "Survivability and causes of loss of broody-hen chicks on smallholder households in Bangladesh." *Preventive Veterinary Medicine*, vol. 83, pp. 260-271.

15. Chowdhury,S.D.(2011), "Destabilization in the Poultry Industry: Ways to overcome the problem", paper presented in the Seminar on "Great Crisis in Poultry industry and ways to overcome the problem" jointly organized by Bangladesh Poultry Industry co-ordination committee and Monthly Khama Bichitra at National Press club on 29th December.

16. Dolberg, F., Mallorie, E. and Brett, N. (2002). "Evolution of the Poultry Model – a Pathway out of Poverty." Paper presented at the workshop "People Fight Poverty with Poultry. Learning from the Bangladesh Experience: http://www.ifad.org/ english/ operations/pi /bgd/documents/ poultry.pdf (July 9, 2008).

17. Du, H. (2008). "Bangladesh Economy: Opportunities and Challenges". Speech, June 17, 2008 to the American Chamber of Commerce: http://www.adb.org/ Documents/Speeches/2008/sp2008031.asp (July 17, 2008).

18. Gopalkrishnan, C.A. and Mohanlal ,G Morley(1994). *Livestock and Poultry Enterprises for Rural development*, Vikas Publishing house Pvt. Ltd., New Delhi, India.

19. Jensen, Hans Askov and Dolberg, Frands. "The Bangladesh Model and Other Experiences in Family Poultry Development- A conceptual framework for using poultry as a tool in poverty alleviation" http://www.fao.org/ ag/againfo/ themes/en/infpd/econf_bang.html

20. Islam, Nabul(2003), Demand projections for poultry products and poultry feeds in Bangladesh No 54, MSSD discussion papers from International Food Policy Research Institute (IFPRI).

21. Jabbar Mohammad A(2007).“Formal and informal contract farming in poultry in Bangladesh”, http://www.fao.org/ ag/againfo/home/events/ bangkok2007/ docs/part3/3_6.pdf

22. Khan, M.M.H., Miah, M.Y., Bhuiyan, M.M., Begum, S., Hussain, M.M. and Khanum, R. (2006). “The Status of Homestead Poultry Production in Sylhet Region.” *International Journal of Poultry Science.* Vol. 5 No.11,pp: 1092-1095

23. Khanum J, Chwalibog A and Huque K S (2005). Study on rural duck production systems in selected areas of Bangladesh. Livestock Research for Rural Development. Volume 17, Article #113: http://www.cipav.org.co/ lrrd/lrrd17/10/khan17113.htm (July 28, 2008).

24. Rahman M M, Baqui M A and Howlider M A R(2004) Egg production performance of RIR x Fayoumi and Fayoumi x RIR crossbreed chicken under intensive management in Bangladesh. Livestock Research for Rural Development. Vol. 16, Art. #92. Retrieved July 8, 2008, from http://www.cipav.org.co/ lrrd/lrrd16/11/rahm16092.htm

25. Rahman, M., Islam, N, Sarker, N.R and Islam, M.M. (1996). Effect of Supplementary Feeding on Production Performance of RIR, Fayoumi and their Crossbred Chicken in Rural Bangladesh. *Bangladesh Journal of Livestock Research,* Volume 5, pp. 184-193.

26. Shamsuddoha, Mohammad(2010).“Sustainable Development of Environment Friendly Commercial Poultry industry in Bangladesh”, November 2, Available at SSRN: http://ssrn.com/abstract=1702073

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 369-390
Bangladesh Economic Association
(ISSN 2227-3182)

Role of Social Capital in Good Governence : The Case of PRDP In Bangladesh

MIHIR KUMAR ROY*
MIZANUR RAHMAN**

Abstract *The study was undertaken with the objective of identifying the institutional mechanisms for promoting transparency, accountability and villagers' participation in GC activities under PRDP link model that emanated from creation of social capital in rural society; and to test a research question i.e. Does formation of social capital contribute to better implementation of GC activities under PRDP link model? To fulfill the objectives and address the research question mainly qualitative analysis was followed, which was supported by content analysis, in-depth case studies, FGD, SSI, informal discussion and consultation covering diverse respondents like general villagers, GC leaders, office bearers of GC, GC male and female members, UP representatives, NBD staff, project officials, field staff, NGO representatives etc. Researcher's personal observation, knowledge and experience gained through institutional attachment were also utilized to enrich the empirical findings. The study revealed that the prolonged intervention of PRDP link model helped formation of social capital in the study area through imbuement and better internalization of a sense of cooperation; togetherness; mutual trust, communication and network; solidarity, developing relationship and interactions among the community activities performed by the GC, which was in fact the pivotal institution of PRDP for ushering development and transformation at the grassroots. It appeared that formation of social capital contributed to GC becoming a relatively effective and socially viable institution for local development that demanded better governance in GC, which ultimately facilitated better implementation of PRDP model in the project villages. It*

* Professor& Dean, Faculty of Business Administration,City University, Dhaka
** Joint Director, Bangladesh Academy for Rural Development, Comilla

was found that the institutional mechanisms of promoting transparency, accountability to the villagers and community participation in GC are embedded in the process of formation of GC. During its long time implementation GC has found a sustainable process of local development through donor's support. But in Bangladesh it has become a common phenomenon that such donor supported best practices end with the withdrawal of donor support and termination of implementation phase. Although overtime GC developed social capital in the project villages but withdrawal support of from the donor may inhibit its self-sustaining strength due to lack of matching grant system and its other unique mechanism of PRDP model. Most of the time experiences and lessons learnt from such donor's support based best practices cannot be properly utilized due to lack of strong advocacy and adopting appropriate means for mainstreaming it nation-wide as such project experiments suffer from the basic problem of sustainability.

The institutional mechanisms of GC and the lessons learnt from the PRDP intervention can immensely be useful for strengthening the role of proposed "gram sava" system enunciated by the present government. GC mechanisms have enormous potential that can help undertake a pro-people and participatory development planning for grassroots development and its lessons can also be useful for other similar type future interventions.

Keywords: *Social Capital, Governance, Participatory Rural Development, Nation Building Departments, Gram Committee, Union Development Officer.*

1. Background of The Study

It is one of the mandated duties of the Bangladesh Academy for Rural Development (BARD) to test contemporary theories and approaches of development in order to develop suitable models for rural development (RD) and thus to suggest policy guidelines to the government. From its inception in 1959 till date, BARD has experimented and also developed quite considerable number of RD models. In its wake it developed an RD model entitled Participatory Rural Development Project (PRDP) through research and action research during the time frame of 1986-1995 in cooperation with a number of academic institutions under the auspices of Japan International Cooperation Agency (JICA). After that, the implementation responsibility of PRDP- popularly known as PRDP link model - was assigned to Bangladesh Rural Development Board (BRDB), which completed its first phase in 2000-2004 and began the second phase commencing from 2005.

PRDP link model, through its two phases, developed unique institutional arrangements of a two-tier committee system. Its institutional arrangement embodies formation of Gram Committee (GC) at the base or village level and Union Coordination Committee (UCC) at the Union level. As per the system of PRDP model, in every village one Gram Committee (GC) is formed comprising 15-20 members on consensus of all the household and representing people from all paras (sub-village) and gushties. A GC representative, chosen on consensus, needs to attend the UCC meeting (UCCM) to inform the decisions of the GC meeting (GCM) for getting required services from the UCC. Addressing the common interest of the villagers, both GC and UCC are empowered to undertake minor schemes up to 50,000 Tk. following a pre-determined system of cost sharing method. According to GC and UCC scheme guidelines (BRDB/JICA: 2008) of the PRDP model, GC can undertake development schemes relating to para road, small culverts, drain, hat/bazaar, bridge, school repair, arsenic free tube well, public library, sanitation etc. based on a matching grant system and fulfilling condition of clearing hundred percent UP tax in that village.

In a traditional society like Bangladesh through the long implementation period in two phases of the PRDP link model - GC helped formation of social capital in the rural society, which eased/facilitated promote some essential conditions of good governance in its entire working procedures. Formation of social capital evolved over a long time amidst social solidarity, interactions and network among diverse groups and people in the community; mutual trust, reciprocity and belongingness; collective actions, shared visions and sense of responsibility based on common interests and mutual benefits among the villagers. All these attributions of social capital resulted in establishment of some basic features of good governance like transparency, accountability and villagers' participation through some institutional mechanisms of GC activities in the community setting. But there is lack of empirical evidence on how such social capital contributes to GC governance. Therefore, the study present was undertaken with a view to identifying those institutional mechanisms for promoting transparency, accountability and villagers' participation in the gram committee system of PRDP link model.

1.1 Objectives of The Study

In line with the stated research problem, the following research objective and research question are set to identify the institutional mechanisms for ensuring governance that emanated from social capital formation in rural society through Gram Committee of PRDP link model.

Specific Objective

The specific objective was to identify the institutional mechanisms for promoting transparency, accountability and villagers' participation in GC activities under PRDP link model that emanated from creation of social capital in rural society;

Research Question

Does formation of social capital contribute to better implementation of GC activities under PRDP link model?

1.2 Scope of The Study

The scope of the study was limited to some particular issues of governance in GC of PRDP link model. A few questions were asked to the GC members, UP representatives, NBDs and NGO field agents and the villagers to know the institutional mechanisms of promoting transparency, accountability and villagers' participation in GC activities of PRDP link model which resulted from formation of social capital in rural communities due to prolonged period of implementation of that project. To answer the research question attempts were made to analyze whether formation of social capital in rural society contribute to better implementation of GC activities under PRDP link model.

1.3 Significance of The Study

The study will be of great significance to the policy makers as building social capital in the village level organization (GC) and its consequence helps ensure a sustainable and cost effective development process at the grassroots. The long time implementation of PRDP model helped develop social capital formation through establishing a good network, relationship, communication, mutual trust, cooperation and togetherness in the rural society/ community people, which that in turn calls for instilling some features of good governance in GC activities through its institutional mechanisms to promote transparency, accountability and increased villagers' participation. Due to the creation of social capital at the grassroots with improved transparency, accountability and increased level of community participation, GC was able to fulfill its mandated functions effectively, which in turn facilitated better implementation of the PRDP link model. The study will also help generate a policy directives and debates on the issue of social capital and its relevance for the rural society. The formation of social capital enables the community people especially the poor to exercise their innovative ideas, local wisdom, exert their voice to influence better and effective service provision using cooperation, support, trust and network, interactions among the villagers themselves. It would also help improve planning and management of local development projects, preparation scheme and proper utilization of resources, etc., which in turn contribute immensely to better implementation of PRDP link model..

1.4 Study Methods

The study was primarily based on qualitative analysis. Data were collected from both primary and secondary sources. Primary data were collected from Chairman, Vice-Chairman, secretary, male and female members of GCs, NBDs extension agents, UP representatives and secretaries, general villagers and project officials. Secondary data were collected by applying content analysis method through looking into project documents, brochures, research reports, GC and UCC resolution, GC guidelines, scheme preparation and approval documents, scheme application form, declaration from for giving soil and land by the land owners for GC scheme, attendance register of GC and relevant books were consulted.

To gather primary data , two Focus Group Discussions (FGDs) composed of 20-25 respondents and three in-depth case studies of 3 GCs were done. Two FGDs comprising of different types of respondents/stakeholders *i.e.* GC members (including Chairman, Vice-Chairman, Secretary, Male and Female members), NBDs extension agents, UP representatives and general villagers were done in *Narandia* and *Sahadevpur* UPs. In *Narandia* UP, representatives from *Mdhokpara Nagarbari, Jadurpara, Prashna, Palima, Char Nagarbari* GC were present. In *Sahadevpur* UP, representatives from *South Chamuria, Baniafair, Akuya, Powjan* were present in the FGD. To have an in-depth understanding about social capital and its aftermath *i.e.* ensuring good governance in GC through its institutional mechanism for promoting transparency, accountability and villagers' participation in GC activities, three case studies - one in Jadurpara GC, one in *Modhokpara Nagrbari* GC and the other in *Char Nagarbari* GC in *Narandia* UP were done.

In both FGDs and Case Studies, few questions containing a short checklist in congruence with the research objective and research question were followed. General villagers' perceptions/opinions were also tapped using informal discussion and SSI (Semi Structured Interview) regarding formation of social capital in rural society and institutional mechanism for enhancing transparency, accountability and villagers' participation through GC activities. In addition to that, consultation with the project officials (DD, AD, Research Officers etc.) and project personnel/staff/field workers were also done. In fine, researchers' personal observation, knowledge and experience gained through institutional attachments were also used to enrich the findings obtained through FGDs, Case Studies, consultations with project personnel and villagers.

1.5 Limitations of The Study

The findings of the study were the outcome of a specifically designed purpose and hence these were not necessarily expected to be confirmed results of the researchers obtained in different contexts. The study was confined only to social capital formation and GC governance of the PRDP-2 link model and hence other aspects were not considered.

The study was mainly based on qualitative analysis and data were collected using FGD, interview and case study method. Due to time and resource constraints the GCs were chosen as per convenience of the researchers. The study would be more fruitful if qualitative analysis could be supported with some quantitative analysis. But the findings of the study would still help the policy makers to draw conclusion and suggest some policy options, which could be enormously useful for undertaking future rural development models in Bangladesh.

2. Theoretical and Analytical Framework

2.1 Theoretical

The concept of social capital occupies a remarkable place in the filed of social science literature over the last few decades. Social capital refers to the resources such as trust and solidarity, social networks, information and communication, association, ideas, supports that individuals are able to obtain by virtue of their relationship and interactions with other people. These “resources” or “capital” are social, meaning that they are only accessible in and through these relationships, unlike physical (tool, technology) and human capital (education, knowledge and skill), which are essentially the properties of individuals (Grootaert *el. al.*, 2004:3). Scholars were in the opinions that building social capital in the society can help solve many critical problems. Formation of social capital takes place in a given society through interactions, relationship, network and cooperation among human beings. It does not grow overnight rather it grows over a long time through its social customs and traditions, norms and values, culture and religions. The evolution of the concept, some definitions, types and sources of social capital are explained.

2.1.1 The Evolution of the Concept of Social Capital

The concept of social capital is not a new concept. The origins and the intellectual history of the concept can be traced back to thinkers of the eighteenth and nineteenth centuries and has deep and diverse roots in philosophy, economics, sociology, anthropology and political science literature (Grootaert and Van Bastelaer, 2002a; Healy and Hampshire, 2002; Adam and Roncevic, 2003). Most authors dealing with social capital argues that L. J. Hanifan, a social reformer, first coined the term, "social capital" in 1916. The basic essence of social capital can be found in the writings of many great scholars/philosophers such as Aristotle, Locke, Rousseau, Durkheim, Marx, Tocqueville, J. S. Mill, Toennies, Weber, Simmel, Adam Smith, Hofsteed and so on (Watson and Papamarcos, 2002; Bankston and Zhou, 2002; Brewer, 2003; Lazega and Pattison, 2001; Portes and Sensenbrenner, 1993; Putnam, 1995; Trigilia, 2001; Portes and Landolt, 1996; Winter, 2000a; Winter, 2000b; Heffron, 2000; Knack, 2002;). In modern time, the concept of social capital has received unprecedented acceptance and application to diverse areas after publication of the landmark book by Robert Putnam in et.al. 1993, *i.e. Making Democracy Work: Civic Traditions in Modern Italy*.

2.1.2 Definition of the Concept of Social Capital

According to Putnam (2000: 19), "Whereas physical capital refers to physical objects and human capital refers to the properties of individuals, social capital refers to connections among individuals – social networks and the norms of reciprocity and trustworthiness that arise from them". In that sense social capital is closely related to what some have called "civic virtue." Putnam underscores the importance of social capital in many ways. Firstly, "social capital allows citizens to resolve collective problems easily. People often might be better off if they cooperate with each other". Secondly, "social capital greases the wheels that allow communities to advance smoothly. Where people are trusting and trustworthy, and where they are subject to repeated interactions with fellow citizens, everyday business and social transactions are less costly". Thirdly, "social capital improves people's lot by widening their awareness many ways in which their fates are linked. When people lack connection to others, they are unable to test the veracity of their own views, whether in the give or take of casual conversation or in more formal deliberation. Without such an opportunity, people are more likely to be swayed by their worse impulses".

The World Bank (1999) has explained social capital in a very simple but significant manner. It says that "social capital refers to the institutions, relationships, and norms that shape the quality and quantity of a society's social interactions. Social capital is not just the sum of the institutions which underpin a society – it is the glue that holds them together".

The available literature reveals that social capital is an admixture of a wide range of issues, which have a bearing on history and culture, social structures, family, education, environment, mobility, economics, social class, civil society, consumption, values, networks, associations, political society, institutions, policy, and social norms at various levels. Social capital does not have a clear, undisputed meaning, for substantive and ideological reasons (Dolfsma and Dannreuther, 2003; Foley and Edwards, 1997). For this reason there is no set and commonly agreed upon definition of social capital and the particular definition adopted by a study will depend on the discipline and level of investigation (Robison *et al*, 2002). Based on the various definitions, it can be summarized that the concept of social capital embodies a huge range of social resources such as bridging, bonding, linking diverse people getting together by virtue of mutual sense of trust, network, reciprocity, cooperation, relationship, friendship, interactions, solidarity, inclusion, empowerment, participation, information and communication, groups and association. Social capital fosters a sense of togetherness among human beings in a given society towards solving myriad socio-economic problems, bringing change and transformation, and ensuring mutual benefits to each other.

2.1.3 Types of Societal Capital

Michael Woodcock (2001), a social scientist from Harvard and the World Bank and Aldridge, Halpern *et. al.* (2002) have made distinction among different types of social capital. According to them there are 3 types of social capital with different meanings and implications, which include bonding social capital, bridging social capital and linking social capital. Bonding social capital denotes ties between people in similar situations, such as immediate family, close friends and neighbours (Woolcock, 2001: 13-14). Bonding is horizontal, among equals within a community whereas bridging is vertical between communities (Dolfsma and Dannreuther 2003; Narayan, 2002; Narayan and Pritchett, 1999). Bonding social capital is localized and it is found among people who live in the same or adjacent communities (Wallis, 1998; and Wallis *et. al.,* 1998).

On the other hand, bridging social capital encompasses more distant ties of like persons, such as loose friendships and workmates (Woolcock, 2001: 13-14). Bridging social capital refers to that social capital, which extends to individuals and organizations that are more removed and bridging social capital is closely related to thin trust, as opposed to the bonding (splitting) social capital of thick trust (Wallis, 1998; Wallis *et. al.,* 1998; Anheier and Kendall, 2002).

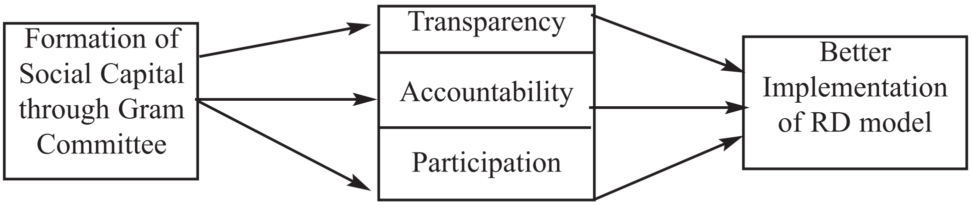
Linking social capital reaches out to unlike people in dissimilar situations, such as those who are entirely outside of the community, thus enabling members to leverage a far wider range of resources than are available in the community (Woolcock, 2001: 13-14). Putnam did not really concern about linking social capital nor did he come to grips with the implications of different forms of social capital rather he opines that ‘different combinations of the three types of social capital will produce different outcomes (Field, 2003: 42). Bonding capital is good for under-girding specific reciprocity and mobilizing solidarity. Bridging networks, by contrast, are better for linkage to external assets and for information diffusion. Moreover, bridging social capital can generate broader identities and reciprocity, whereas bonding social capital bolsters our narrower selves. Bonding social capital constitutes one kind of sociological superglue, whereas bridging social capital provides a sociological (Putnam, 2000: 22-23).

The other important distinction of social capital, developed by Norman Uphoff and Wijayaratna (2000), spans the range from structural manifestations of social capital to cognitive ones (Grootaert and Van Bastelaer, 2002a). Structural social capital facilitates mutually beneficial collective action through established roles and social networks supplemented by rules, procedures and precedents (Hitt *et. al.*, 2002). Cognitive social capital, which includes shared norms, values, attitudes, and beliefs, predisposes people towards mutually beneficial collective action (Krishna and Uphoff, 2002; Uphoff, 1999). Cognitive and structural forms of social capital are commonly connected and mutually reinforcing (Uphoff and Wijayaratna, 2000).

2.2 Analytical Framework

Through the long implementation period of PRDP link model aiming at grassroots development, social capital formation occurred in the project villages, which in turn calls for ensuring good governance in the activities of GC. Here in this study “social capital” refers to relationship, fellow feelings, trust and solidarity, groups and network, collective action and cooperation, information and communication, social cohesion and inclusion, norms, values and practices followed by the villagers, empowerment and participation of the villagers, which is developed through various institutional mechanisms in managing the entire development process/ activities of GC under PRDP link model. Using an analytical framework, how formation of social capital helps promote transparency, accountability and villagers’ participation and better implementation of PRDP model is explained. The main argument of this analytical framework is based on the premise that through the interventions of the PRDP model, some forms of social capital is formed at the community level. Such formation and accumulation of the social capital result in demand for and practice of transparency, accountability and participation at the community level. These features of good governance ultimately made the PRDP model relatively successful and effective in terms of its project indicators. The analytical framework can be well understood in the following diagram:

Diagram of Analytical Framework



3. The Concept of The PRDP Link Model

PRDP is one of the interventions of the BRDB, that aims at developing a mechanism of coordination among Union Parishad (UP), Nation Building Departments(NBDs) and NGOs for ensuring effective service delivery by the NBDs and NGOs at the grassroots level. PRDP, popularly known as link model, has devised an institutional framework to address real needs and problems of development of the rural population following a vertical linkage among villages, Union and Upazila and horizontal linkage among villagers, extension agents or field workers of the government institutions, NGOs and other stakeholders concerning rural development at Union level. The objective of the PRDP link model is to bring a comprehensive rural development at Union and Village level through a participatory governance mechanism, ensure effective service delivery of NBDs-NGOs extension agents, building micro infrastructure towards improving socio-economic condition of the villagers using local resources and its proper utilization, develop human resources, strengthen UP by developing a mechanism of coordination of all development organizations and promote accountability and transparency among all stake holders in the Union.

3.1 The Institutional Arrangement of The Link Model

PRDP link model is a unique institutional arrangement of PRDP, a two-tier committee system through which participatory bottom-up planning process has been practicing to incorporate the unheard voices, real choices and needs of the community people/villagers. At the base or village level there is Gram (Village) Committee (GC) and at the Union level there is Union Coordination Committee (UCC). In every village one Gram Committee (GC) is formed comprising 15-20 members on consensus of all the house hold and representing people from all paras(sub-village). A VC representative is chosen on consensus, who needs to attend the UCC meeting (UCCM) to inform the decisions of the GC meeting (GCM) for getting required services from the UCC. In the upper tier there is Union Coordination Committee (UCC) at the Union level headed by the UP Chairman comprising of all UP members, extension agents of all NBD functionaries as well as NGOs working at the Union level and representatives of the village committees including women groups. Both GC and UCC meet once a month regularly to discuss their various development agenda. NBD workers need to present their village visit schedules, work plans and programs in the UCC meeting.

Addressing the common interest of the villagers, GC and UCC are empowered to undertake minor schemes up to 50,000 Tk. following a pre-determined system of cost sharing method. According to GC and UCC scheme guidelines (BRDB/JICA: 2008) of the PRDP model, GC can undertake development schemes relating to para road, small culverts, drain, hat/bazar, bridge, school repair, arsenic free tube well, public library, sanitation etc. sharing 20% cost by the villagers, 10% cost by the UP and 70% cost by the PRDP on condition that 100% UP tax are realized in that village. The GC schemes should have to be single village oriented. In case of UCC scheme 30% cost should be shared by UP and other stakeholders that include NBDs, NGOs and GCs, and the rest 70% cost is to be borne by the PRDP. UCC can take schemes concerning educational/environmental event (such as organizing tree fair, book fair), cultural event (like pitha mela, observation of mother language day, victory day and independence day), procurement (such as purchasing of sewing machine, arsenic test kit, pesticide spray machine, etc.) and flood rehabilitation (*i.e.* bamboo bridge construction, seed distribution, earth filling work, etc.). For both GC and UCC schemes, notice boards should be installed in prominent locations of the villages to disseminate vital information to the villagers about the schemes and important decisions of the GCM and UCCM to ensure transparency and accountability of all concerned.

In PRDP a new position was created called Union Development Officer (UDO). UDO is deployed at the Union level and he needs to work as a catalyst keeping contact among all concerned for organizing villagers, coordinating development activities by establishing linkage between villagers and government and NGO extension workers, helping the villagers in preparing plan, implementation and monitoring of schemes. UDO also acts as a member secretary of the UCC. GCM is a unique platform of villagers to discuss about their problems, and decide upon issues of common interest and implement whatever is decided with ownership and cost sharing. In the UCCM, GC representatives, UP members, NBD functionaries, NGO representatives of the locality exchange information and opinion freely and take necessary decisions.

3.2 Formation Process and Activities of Gram Committee of PRDP Model

A Gram Committee is formed at village level including the respected persons of the village with villagers consent. It is an informal forum formed in presence of the villagers taking the proposals from each para and clan (family) and supports from all. Needs are be placed on priority basis identifying the problems of the village. In GC opportunities are created for the villagers to be organized together. Villagers get necessary advice from the govt. and non-govt. workers in the GCM. The main objectives are to adopt necessary measures for village development oriented discussions. GCM is primarily a media at village level, which assembles the villagers to be univocal and communicate the service providers. One representative from the GC will be the member of Union Coordination Committee Meeting (UCCM). The meeting is held in presence of at least one person from each household of the village. It is known as General Meeting. To form GC, general meeting should be arranged first. Meeting is held with the elected members of the GC. It is known as Gram Committee Meeting (GCM).

4. Social Capital Formation and Features of GC Governence in PRDP Model

Through this study an attempt was taken to look into institutional mechanisms for promoting some essential features of GC governance under PRDP link model, which is basically the end product of social capital formation through the GC and other project interventions at the grassroots. The formation of social capital has created demand and urge for practicing governance in GC. This study tries to unravel the institutional mechanisms of GC governance in three core areas of governance such as transparency, accountability and participation of the villagers in the GC. In order to ensure that several methods were adopted that included FGD with GC members, NBDs agents, UP functionaries, project officials and the general villagers, case studies on GC, consultations with the villagers and project official.In this section, a brief three case studies were elaborated to understand the issues of ensuring transparency, accountability and villagers' participation in GC activities in the PRDP link model.

4.1 Transparency in GC

Social capital formation through GC calls for practicing of good governance and more transparency in GC activities. Transparency means openness in every activities of an organization or institution.

Transparency is a process and an end itself that implies making relevant information available to all who are interested and whose interests are involved in any action or decision taken for them in order to enable them to make or to participate or to help that act. There are differences of meaning of transparency at national and local level. At local level transparency refers to the provision of relevant and reliable information to all the members involved (Manasan *et. al,* 1999). In other words, transparency means making all information available to the members. In this study, transparency means "maintaining openness" and "sharing of GC activities and decisions with the villagers".

4.2 Accountability in GC

Social capital formation in the rural society can buttress argument for promoting accountability in the GC affairs. Accountability entails an obligation to report its activities, role and performance to an agreed authority or set of people. According to Manasan *et. al.*(1999), accountability refers "the ability of the villagers to exert pressure on the field workers to serve. In this study accountability refers to the answerability of the members of GC to the villagers for their actions, inactions and decisions.

4.3 Villagers' Participation in GC

Formation of social capital through GC facilitated villagers' participation in different activities of GC. Participation is a very wide and complex concept. Participation refers to the close involvement of the people from all walks of life irrespective of sex, race, group, caste, colour and religion in economic, social, cultural and political decision-making process of an area (UNDP, 1993). According to the World Bank (2002), participation is the process through which stakeholders' influence and share control over priority setting, policy making, resource allocation and access to public goods and services. In this study "participation" means the villagers' involvement in any activities undertaken by GC for the interest of the villagers.

5. Major Findings

Formation of social capital developed through long duration of the project that helped instill a sense of mutual cooperation, trust and network, social cohesion, solidarity, communication and interactions among the villagers. Such formation of social capital through GC created space for practicing good governance in the realm of GC activities. In promoting GC governance, three core issues of good governance such as ensuring transparency, accountability and villagers' participation in GC activities were emphasized.

Transparency, accountability and participation are interrelated concepts, which are so intricately enmeshed together that cannot be isolated from each other. Some mechanisms of GC cover three issues simultaneously, whereas transparency and accountability are also intermingled together. On the basis of FGD, case study, SSI and interview with general villagers the following findings were derived regarding formation of social capital through ensuring mechanism of transparency, accountability and enhancing community participation in the GC activities.

5.1 Institutional Mechanisms of Promoting Transparency, Accountability and Villagers' Participation in GC

The following institutional mechanisms of GC, helped promote transparency, accountability and villagers' participation in GC activities, which in fact emanated from formation of social capital in the rural society through GC:

- **Formation of C:** In the formative stage attempts were made to ensure transparency in GC. Before formation of GC, Japan Overseas Cooperative Volunteers (JOCVs) along with other project personnel helped motivate the villagers through motivation, video presentation to form GC in a village. At that stage a comprehensive base line survey was conducted to record the socio-economic status and number of total household. On the basis of that survey, attempts were made to organize some Para-based meeting and after a massive consultation with the inhabitants of all *Paras* and *Gushties* of that village, a general meeting was convened representing representatives of all house-hold/people from all *Paras* and *Gushties.* In this general meeting (GM), in the presence of at least 60% HH, GC Chairman, Vice-chairman, members were chosen on consensus. In this body one-third women's participation is maintained. After that, this entire body of GC is to be approved by the GM. The formation process of GC ensured transparency, accountability and enhanced villagers' participation in GC activities.
- **Organizing GC meeting in every month:** All village based GC used to organize a monthly meeting at a suitable date. Some GC maintains a particular day/date of every month. It was agreed that all the GCs do that GCM on regular basis. Regular meeting helps ensure transparency, accountability and participation of the villagers in GC activities.

- **Use of registered *khata*:** In order to record the attendance of the general villagers, GC members and other concerned, and also issues and decisions discussed and finalized, a registered *khata* is used in GC. Any villager has more or access to it. This mechanism helps in promoting transparency, accountability and villagers' participation in GC activities.
- **Distribution of resolution to share important decisions of the GC:** Major important decisions of GC are shared with the common villagers and other stakeholders *i.e.* UP, NBDs, UDO, UCC, through distribution of GC resolution. Such sharing information with the villagers helps ensure responsible behavior, transparency, accountability and villagers' participation in GC activities.
- **Provision of obtaining certificate from UP regarding tax clearance:** Following a decision taken by the GC meeting and getting approval from the UCC and PRDP-2 authority, GC needs to obtain a certificate of clearance of 100% tax from the UP before undertaking any scheme by GC. In doing so GC members requires making approach to the villagers in order to convince the villagers to pay taxes fixed upon them. In collecting such taxes, UP needs to give a receipt/voucher to the taxpayers, thus every taxpayer is aware of the schemes to be taken. This has significantly contributed to promoting transparency, accountability and villagers' participation in GC affairs.
- **Cost sharing/Matching Grant System:** According to matching grant system, undertaking any project needs to be shared by the villagers, UP and the PRDP. In implementation of any GC scheme general villagers need to bear 20% cost from their own. As the villagers pay contribution for the GC scheme, so all GC members are very much concerned about the schemes performance. Matching grant system of GC helped enhancing transparency, accountability and villagers' participation in GC activities.
- **Formation of Scheme Implementation Team (SIT):** For implementation of any development undertaking by the GC, a Scheme Implementation Team is formed comprising of 5-7 villagers representing different stakeholders such as GC Chairperson, one female GC member, UDO, GC secretary, concerned NBD members, teachers, and any relevant villager having UP membership as its adviser. The formation of SIT helps to maintain transparency, accountability and enhancing the scope of participation of the villagers in GC scheme.

- **Introduction of notice board and display board:** In the PRDP-2 link model, GC is in the practice to use the notice board widely. Important decisions made in the GC resolutions, scheme related decisions, any important messages of the UP and NBDs, NBDs posters and scheme budget, procurement/expenditure statement of the scheme etc. are generally affixed in the notice board, which needs to be set up at the important places of the villages. Through these notice boards, and display boards accountability and transparency are maintained in the GC to the villagers. Sharing relevant information through notice and display boards also encourage villagers' participation in GC affairs.
- **Organization of inauguration ceremony:** Overtime it has become a general practice for the GC that at the start of the project and after successful completion of the GC scheme, each and every GC organizes an inaugural ceremony to inaugurate the scheme, where rural elites and general villagers are invited to participate in it. Thus GC ensured social accountability, transparency and participation of the villagers.
- **Preparation of social map/measurement and cost estimation:** After formation of the SIT, it needs to prepare a social map/measurement and estimated budget of the proposed scheme. Being physically present at the project site, SIT prepares this measurement and budget in consultation with the villagers of that locality/para, which helps promoting transparency, accountability and increase participation of villagers in GC affairs.
- **Organization of para meeting:** After getting preliminary approval from the UCCM, GC needs to organize a para meeting to share the information with the people of the scheme area. Through detailed discussion with the villagers it is finally chosen and in this meeting commitment of cost sharing amount by the villagers is recorded with their signatures. This also helps in ensuring transparency, accountability and participation in GC activities. Organizing para meeting for scheme undertaking helps the villagers bonding together for mutual help, support and common interest/purpose.
- **Organization of annual general meeting at the end of the year:** Every C organises an annual meeting (AGM) at the end of the year to review their last year's performance. This AGM performs a system of social audit in the GC, which helps ensure transparency, accountability and participation in GC.

- **Scheme initiation, selection, preparation and approval process:** In the whole process of scheme initiation, selection, preparation and approval of a GC scheme, transparency and accountability is maintained in the PRDP-2 project. When a bottom-up, need based scheme is finally decided to be undertaken, a SIT is formed. The SIT needs to prepare the detailed cost estimation of that scheme after filed observation and consultation with the villagers of that area. Then SIT needs to finalize the total cost of the scheme and fix the cost shared by the general villagers, UP and PRDP-2. Then it is sent to project office for final approval. Thus transparency and accountability is maintained in the entire process of scheme selection to finalization in GC.
- **Submission of completion report by the SIT:** After completion of the scheme, SIT needs to prepare a detailed completion report containing total expenditure statement, all original vouchers and master roll payment along with other related documents as per need of the completion report format. Thus transparency and accountability in GC scheme is properly maintained.
- **Signing in a declaration form by the landowners for providing soil and land for construction of earthen road:** The landowners, who need to provide either soil or land for erecting earthen road, need to be prefixed in consultation with the landowners and villagers, which is being recorded and signed by the respective landowners in a format provided by the project authority. Here GC needs to sit and negotiate with the landowners several times as in some cases it is found that at the eleventh hour some landowners sometime fail to keep their previous commitment. This mechanism of GC helped develop transparency, accountability and participation of the villagers.
- **GC maintains a cost effective mechanism of labor payment system:** Instead of daily payment system for the labour employed in earthen work in GC scheme, GC introduced a new system of labor payment, which is based on performance. Instead of daily payment system followed by KABIKHA, TR or KABITA in UP earthen work/project, GC measures the labourers' work by cubic feet, so that no labour can avoid work. In presence of general villagers, UDO and SIT members measure the work and prepares the master roll, thus a participatory, transparent and cost effective project implementation is ensured in GC.

- **Areas of villagers' participation in GC:** It is learnt from the informal discussion with the villagers in the different studied GCs, general villagers have participation in paying taxes, sharing contribution of scheme, attendance in GC meeting, giving soil and land for construction of road. Villagers' increased participation is observed when important schemes are to be taken by the GC, especially concerned villagers of that para or gushti took part being previously informed about the meeting. The villagers also take part in local rally, local cultural activities, inauguration of any scheme, in annual general meeting.

5.2 Lesson Learnt from this Study

The lesson learnt from the study might be useful for the policy planners, which are presented in bullet from below

- Cintroduced a bottom-up participatory planning process at the grassroots.
- eneral villagers participation are higher in women dominated GC.
- GC established a horizontal and vertical accountability.
- GC introduced social accountability.
- GC introduced a social audit system.
- GC leaders are socially acceptable to the community people.
- GC follows an inclusive strategy.
- Villagers feel ownership of the GC.
- NDB service delivery improved.
- Income generating activities improved.
- Women development and empowerment through training organized by PRDP.
- Litigation in the village dwindled immediately.
- Villagers' tax payment tendency improved.
- Integrity of GC leaders is maintained because of the matching grant system.

6. Recommendations and Conclusion

On the basis of the study findings, following recommendations and conclusions are made:

Recommendations

6.1 UP's role should be enhanced in GC

UP's role in GC should be further expanded so that UP can extend all out support to GC activities, which in turn help develop a sense of ownership of the GC. Women UP members should be included in GC as members and involved in all activities of GC. UP as a legitimate local government institution at the grassroots, should not be bypassed, rather its role should be enhanced because GC in the long run may face problem to achieve sustainability and ownership. This is in line with the present government's enact went of the new UP Act in 2009, which has made provision to form ward shava in order to engage villagers in participatory planning and local development.

6.2 Encourage forming separate women GC

In our society, especially the condition of rural women foke is not satisfactory and they are still lagging behind in all aspects compared to man. In rural life women have to suffer from malnutrition, unemployment, violence and they lack in modern knowledge and technology. That's why women should be brought into the mainstream of development. Therefore, more intervention and some affirmative action should be provided to women. In a bid to overcome the problems, effort should be taken to form or to organize women in separate GC as it is evident that women have enormous potentiality to motivate and encourage others and thus to build relationship, interaction, solidarity, network, trust with flexible attitude, shared responsibility and engrained integrity and trustworthiness.

6.3 Making provision of publishing an annual report by GC

To record all the development undertakings and activities performed in the last year by the GCs, an annual report can be introduced. This report can be prepared covering the activities of 5-10 GCs altogether. This report may contain some basic socio-economic information of the villages, profiles of GCs, details of GC members and description of their development activities done in the last year. This report can help recording the achievement and failures of the GC, which can help create better social capital with improved transparency, accountability and responsibility of the GC leadership.

6.4 NGO's role should be enhanced in GC activities

To increase the civil engagement and social capital formation in GC, NGO representatives should be involved in the Scheme Implementation Team.

Provision should be made to involve NGO representative in the GC, which can help establish more transparency, accountability and participation of the villagers.

6.5 Limit of GC scheme allocation should be enhanced

For initiating micro- infrastract in the village level, the financial support provided from the PRDP/JICA is to some extent insufficient in the context of present day. Therefore, the ceiling of total cost should be increased.

Conclusions

Based on empirical evidence gained it was apparent that formation of social capital contributed to GC becoming GC a relatively effective and socially viable institution for local development. It was found that the institutional mechanisms of promoting transparency, accountability to the villagers and community participation in GC are embedded in the process of formation of GC and SIT. During its long time of implementation GC has found a sustainable process of local development through donor's support. But in Bangladesh it has become a common phenomenon that such donor supported best practices end with the withdrawal of donor support and termination of implementation phase. Although overtime GC developed social capital in the project villages but withdrawal support by the donor may inhibit its self-sustaining strength due to lack of matching grant system. Most of the time experiences and lessons learnt from such donor's support based best practices cannot be properly utilized due to lack of strong advocacy and adopting appropriate means for mainstreaming it nation-wide as such project experiments suffer from the basic problem of sustainability. The institutional mechanisms of GC and the lessons learnt from the PRDP intervention can immensely be useful for strengthening the role of proposed "gram sava" system enunciated by the present government. GC mechanisms have enormous potential that can help undertake a pro-people and participatory development planning for grassroots development and its lessons can also be useful for other similar type of future intervention.

References

1. Adam, Frane, and Borut Roncevic. (2003). "Social Capital: Recent Debates and Research Trends", *Social Science Information* 42: 155-183.

2. Anheier, Helmut, and Jeremy Kendall. (2002). "Interpersonal Trust and Voluntary Associations", *British Journal of Sociology* 53: 343-362.

3. Bankston, Carl. L. and Min Zhou. (2002). "Social Capital as a Process: The Meanings and Problems of a Theoretical Metaphor", *Sociological Inquiry* 72: 285-317.

4. Brewer, Gene A. (2003). "Building Social Capital: Civic Attitudes and Behavior of Public Servants", *Journal of Public Administration Research and Theory* 13: 5-26.

5. Dolfsma, Wilfred, and Charlie Dannreuther.(2003.)"Subjects and Boundaries: Contesting Social Capital-based Policies", *Journal of Economic Issues* 37: 405-413.

6. Foley, Michael W. and Bob Edwards.(1997.) "Escape from Politics? Social Theory and the Social Capital Debate", *American Behavioral Scientist* 40: 550.

7. Grootaert, Christiaan, and Thierry Van Bastelaer(2002a) 'Conclusion: Measuring Impact and Drawing Policy Implications", in Thierry Van Bastelaer. (Edited). 2002. *The Role of Social Capital in Development*, (Melbourne: Cambridge University Press).

8. Healy, Karen and Anne Hampshire.(2002.) "Social Capital: A Useful Concept for Social Work?" *Australian Social Work* 55: 227-238.

9. Heffron, John M. (2000). 'Beyond community and society: The externalities of social capital building.' *Policy Sciences* 33: 477-494.

10. Hitt, Michael A, Ho-Uk Lee, and Emre Yucel.(2002.) "The Importance of Social Capital to the Management of Multinational Enterprises: Relational Networks among Asian and Western Firms", *Asia Pacific Journal of Management* 19: 353.

11. Knack, Stephen.(2002.) "Social Capital and the Quality of Government: Evidence from the States", *American Journal of Political Science* 46: 772-785.

12. Krishna, Anirudh, and Norman Uphoff.(2002.)"Mapping and Measuring Social Capital through Assessment of Collective Action to Conserve and Develop Watersheds in Rajasthan, India", in Thierry Van Bastelaer. (edited). 2002. *The Role of Social Capital in Development*, (Melbourne: Cambridge University Press).

13. Lazega, Emmanuel and Phillipa E. Pattison(2001.) "Social Capital as Ssocial Mechanisms and Collective Assets: The Example of Status Auctions among Colleagues", in Ronald Burt (edited). 2001. *Social Capital: Theory and Research*, (New York: Aldine de Gruyter).

14. Manasan, R. G., Gonzalez, E. T. and Gaffud, R. B.(1999.) "Indicators of Good Governance: Developing an Index of Governance Quality at LGU Level", *The Journal of Philippines Development,* Vol.24, No.48, 1999.

15. Narayan, Deepa and Lant, Pritchett.(1999). "Social Capital: Evidence and Implications", in Ismail Serageldin. (edited). 1999. *Social Capit(al: A Multifaceted Perspective*, (Washington, DC: World Bank).

16. Narayan, Deepa(2002). "Bonds and Bridges: Social Capital and Poverty", Sunder Ramaswamy. (edited). 2002 in *Social Capital and Economic Development: Well-being in Developing Countries*, (Cheltenham, UK: Edward Elgar).

17. Portes, Alejandro, and Julia Sensenbrenner(1993) “Embeddedness and Immigration: Notes on the Social Determinants of Economic Action”, *American Journal of Sociology* 98: 1320 - 1350.

18. Portes, Alejandro and Patricia Landolt(1996.)“The Downside of Social Capital”, *The American Prospect* 26: 18-23.

19. Putnam, Robert D, Robert Leonardi, and Raffaella Y Nanetti. 1993. *Making Democracy Work : Civic Traditions in Modern Italy,* (Princeton, N.J.: Princeton University Press).

20. Putnam, Robert D(1993/1995) “Bowling Alone: America’s Declining Social Capital”, *Journal of Democracy* 6: 65-78.

21. Putnam, R. D. (2000.)*Bowling Alone: The Collapse and Revival of American Community*, (New York: Simon and Schuster).

22. Robison, Lindon J., A. Allan Schmid, and Marcelo E. Siles((2002). “Is social capital really capital?” *Review of Social Economy* 60: 1-24.

23. Trigilia, Carlo.(2001.) “Social Capital and Local Development”, *European Journal of Social Theory* 4: 427-442.

24. UNDP. 1993. *Human Development Report 1993*, (New York: UNDP).

25. Uphoff, Norman, and C. M. Wijayaratna. (2000.)“Demonstrated Benefits from Social Capital: The Productivity of Farmer Organizations in Gal Oya, Sri Lanka”, *World Development* 28: 1875-1890.

26. Uphoff, Norman. (1999.) “Understanding Social Capital: Learning from the Analysis and Experience of Participation”, in Ismail Serageldin. (edited). 1999. *Social Capital: A Multifaceted Perspective*, (Washington, DC: World Bank).

27. Wallis, Allan, Jarle P. Crocker, and Bill Schechter.(1998.) “Social Capital and Community Building, Part 1”, *National Civic Review* 87: 253-72.

28. Wallis, Allan.(1998). “Social Capital and Community Building, Building Healthier Communities: Ten Years of Learning, part 2”, *National Civic Review* 87: 317-19.

29. Watson, George W., and Steven D. Papamarcos.(2002.)“Social Capital and Organizational Commitment”, *Journal of Business and Psychology* 16: 537-552.

30. Winter, Ian(2000a.)“Major Themes and Debates in the Social Capital Literature: The Australian Connection”, in Ian Winter. (edited). 2000. *Social Capital and Public Policy in Australia*, (Melbourne: National Library of Australia).

31. Winter, Ian..(2000b.)“Social Capital and Public Policy in Context”, in Ian Winter. (edited). 2000. *Social Capital and Public Policy in Australia*, (Melbourne: National Library of Australia).

32. Woolcock, Michael.(1998.)“Social Capital and Economic Development: Towards a Theoretical Synthesis and Policy Framework”, *Theory and Society* 27: 151-208.

33. World Bank. (1999.)What is Social Capital?, *www.worldbank.org/poverty/scapital/whatsc.htm*

34. World Bank.(2002.)Promoting Social and Public Accountability- Participatory and Community Based Monitoring and Evaluation, (Uganda Videoconference: World Bank).

Bangladesh Journal of Political Economy

Vol. 29, No. 1, June 2013, pp. 391-403
Bangladesh Economic Association
(ISSN 2227-3182)

Present Status of Shrimp at the Stage of Production and Marketing: A Study in Khulna District of Bangladesh

B. K. Dev*
Md. Nuruzzaman**

Abstract *The marine water shrimp and freshwater prawn is commercially cultured in Bangladesh's Khulna. Thousands of farmers in this area have converted their paddy fields to shrimp and prawn farms to adopt a profitable shrimp culture practice. Farmers directly sell their shrimps to the local markets during March-May/June and prawns during October/November-January/ February. However, now the production of shrimp and prawn are take places all around the year. The shrimp/prawns supply chain from farmers to the international markets always pass through a number of middlemen: foria (field workers), prawn traders, agents and companies. The growing production in shrimp and prawn farming in Khulna region and rising export are generating employment in this sector. Suitable trade infrastructure conducive to shrimps export should be established and strict compliance with requirements of importing countries by shrimp processors and exporters should be ensured in order to advance the sector.*

1. Introduction

The culture of shrimp in Bangladesh has been drawing greater attention by fish farmers, particularly in brackish waters. In the coastal area of the greater Khulna region having a tropical climate, productive and unpolluted estuarine areas are

* Bishwajit Kumar Dev, Fisheries Extension Officer, Department of Fisheries, Ministry of Fisheries and Livestock
** Md. Nuruzzaman, Director (Training), National Academy for Planning and Development, Dhaka

considered to be a suitable natural habitat for penaeid shrimp culture (Ali et al., 2000). The latest estimate of the area of land under shrimp cultivation in Bangladesh is about 140,000 ha (BBS 1996). Shrimp farming plays a significant role in the economy of Bangladesh. Processed shrimp comprises the second largest export commodity of the country. Shrimp farming also generated diverse employment opportunities; In 1993, about 87000 persons were involved in shrimp farming and another 5000-6000 in shrimp processing industries (Hussain, 1994). This number is now 3.5 lakh in Khulna region. In addition, about 300,000 to 500,000 persons are involved in shrimp larvae collection for shrimp farming (Ali, 1992). Due to its tremendous potential, the area under shrimp faming has been increasing rapidly every year in Bangladesh. About 140,000 ha of land in the coastal region is under shrimp farming, of which about 125,000 ha is used for brackish water shrimp farming and about 15,000 ha for fresh water giant prawn farming (BFRI, 1996). Now in Khulna district about 58,472 ha is under shrimp farming. About 80% of the tiger shrimp comes from the south western region of Bangladesh *i.e.* greater Khulna region. The rapid expansion of shrimp farming over the last decade and its contribution to foreign exchange earnings has been quite remarkable. In 2005-06 the total foreign exchange earnings from shrimp export was Tk. 2100 crore. Shrimp culture covered an area of 1.4 lakh ha in 1995-96 in contrast to 0.87 ha in 1985-86 (DoF 1998). The biology of these two species is mostly associated with the salinity of the environment. Khulna region is geographically situated in the mixed climatic condition between fresh, brackish and marine environment. Marine shrimp and fresh prawn are both suitable culture in this ground. In the last few years horizontal expansion of shrimp cultivation in Bangladesh occurred rapidly, but unfortunately, due to improper management practices appropriate level of production of shrimp was not achieved. Both low production rate such as 197.4 to 225.6 kg/ha/season (Hoq et al., 1997) and poor management practice both appear as the major hindrance to competing in the international market, which deprive the country from earning more foreign exchange. Shrimp farming technology followed by most of the farmers of Bangladesh is rather primitive and inefficient and it is also difficult to effectively apply any improved culture technology in existing farms because most of them are unmanageably large in size, shallow in depth, irregular in shape (Karim, M., and Aftabuzzaman. 1995). Successful shrimp farming depends on its good management and improved system at various culture practices. In summary, the commercial development of shrimp and prawn farming is geographically broad but piecemeal and, with a few exceptions, nationally insignificant in terms of volume production. The goals of the study are to estimate the production, marketing system and channel as well as to evaluate employment generation and manpower involvement in shrimp farming.

2. Materials and Methods

2.1 Study area

Khulna district: 10 Upazila viz., Koyra, Paikgacha, Dumuria, Fultala, Digholia, Terokhada, Rupsha, Batiaghata, Dacope and Metro respectively.

2.2 Species

Fresh Water Giant Prawn *(Macrobrachium rosenbergii) and* Marine Water Giant Tiger Shrimp (*Paeneous monodon*)

2.3 Data collection method

Questionnaire, interviews, Literature review, Field visit, Personal contact.

2.4 Methodology

The survey covered the period of seven months from January to July in 2006. The data was collected by using questionnaire interviews with prawn traders and participatory rapid appraisal (PRA) tools like Focus Group Discussion (FGD) with shrimp/prawn farmers. Shrimp traders for face to face questionnaire interviews were selected by random sampling. Interviews were conducted in the market places. PRA tools were used to get an overview of some particular issues like shrimp/prawn harvesting and marketing. A sample survey on 68 shrimp traders in different markets of Khulna district was conducted for data collection. Cross check interviews were conducted with many respondents of different categories as far as possible.

2.5 Data analysis

2.5.1 Computer software support

i) MS Word ii) MS Excel iii) SPSS

2.5.2 Production counting

Production of Upazila = Average production from 3 to 15 depots X total depots of each market in the Upazila.

2.5.3 Test

t-test: paired two samples for means
Linear regression analysis

i) $y = a + bx$ (Hosmand, 1988)
ii) y = co-ordinate value along the vertical axis (dependant variables)

x = co-ordinate value along the horizontal axis (independent variables)

a = intercept of the curve

b = slope of the curve.

iii) Co-relation co-efficient 'r'

$$r = \frac{\Sigma xy}{N \sigma_x \sigma_y}$$

Where,

$x = x_i - x$, $y = y_i - y$, σ_x= Standard deviation of series x, σ_y= Standard deviation of series y, N= Number of pair of observation

3. RESULTS AND DISCUSSION

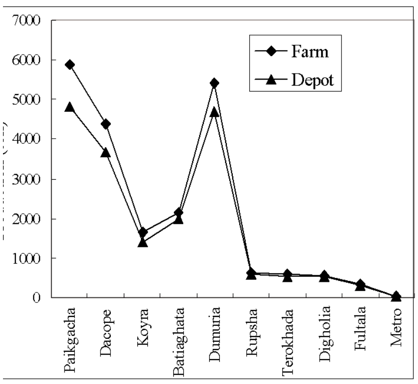
3.1 Production of shrimp and prawns from the Khulna district of Bangladesh

The approximate annual production of shrimp and prawn was estimated from the Khulna district of Bangladesh through regular field survey at monthly interval from Upazila fisheries Office and randomly selected shrimp depots of Paikgacha, Dacope, Koyra, Batiaghata, Dumuria, Rupsha, Terokhada, Digholia, Fultala, and Metro Upazila in Khulna district and gross production from the farms of that Upazilas for a period of six month from January to June, 2006. The production wascounted in two ways in all Upazilas. Firstly, the annual harvest of shrimp was counted monthly from Upazila fisheries Office by turn. Secondly, the production was counted from randomly selected depots. The total harvest of shrimp and prawn and observed production in shrimp depots in Khulna district was 21611 and 18620 ton, respectively, and the total area of shrimp farming was 58472 hector. The annual total harvest of shrimp was 5873, 4388, 1636, 2145, 5416, 616, 582, 569, 345 and 41 tons at Paikgacha, Dacope, Koyra, Batiaghata, Dumuria, Rupsha, Terokhada, Digholia, Fultala, and Metro Upazila in Khulna district, respectively. The annual total shrimp production in depots was 4833, 3675, 1408, 1992, 4694, 602, 529, 537, 311 and 39 tons at Paikgacha, Dacope, Koyra, Batiaghata, Dumuria, Rupsha, Terokhada, Digholia, Fultala, and Metro Upazila in Khulna district, respectively. The total shrimp farming area are 17276, 12680, 4530, 6253, 13284, 1178, 1102, 1070, 987 and 112 hector at Paikgacha, Dacope, Koyra, Batiaghata, Dumuria, Rupsha, Terokhada, Digholia, Fultala, and Metro Upazila in Khulna district, respectively. Both the maximum production of farm (5873) and depots (4833) were found in Paikgacha and the minimum was 41 ton and 39 ton in Metro Upazila (Table-1 and Figure-1).

In all level of production there is some loss that may hamper the production frequency. In shrimp production, a major loss occurs from harvesting to depot, which affects the primary stakeholder. The rate of rejection of shrimp over from

Table 1: Upazila wise area of shrimp farm and production from farm and depots

		Production (ton)	
Upazila	Area (ha)	Farm	Depot
Paikgacha	17276	5873	4833
Dacope	12680	4388	3675
Koyra	4530	1636	1408
Batiaghata	6253	2145	1992
Dumuria	13284	5416	4694
Rupsha	1178	616	602
Terokhada	1102	582	529
Digholia	1070	569	537
Fultala	987	345	311
Metro	112	41	39
Total	58472	21611	18620



gure-1: Production variation from Farm to Depots

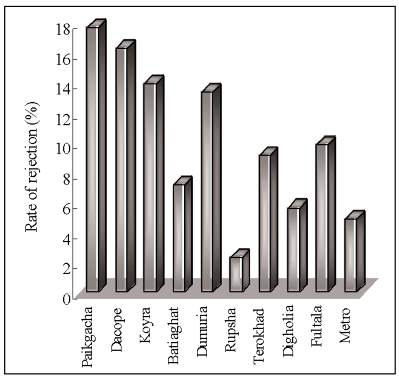


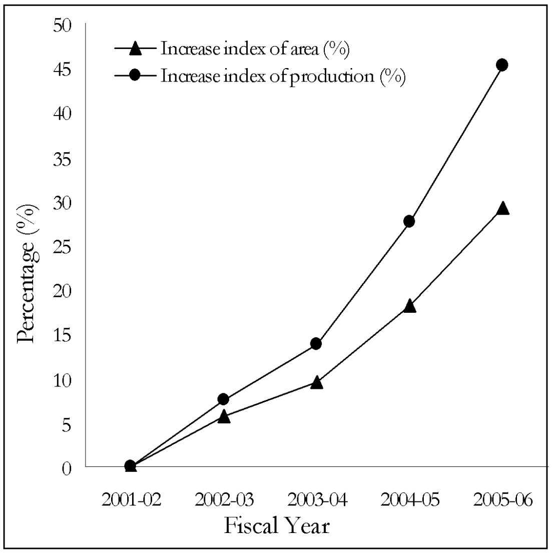
Figure-2: Percentage change of the rejection rate over Production from Farm to Depots

farm to depots are 18%, 16%, 20%, 7%, 12%, 2%, 13%, 9%, 10% and 5%, respectively, at Paikgacha, Dacope, Koyra, Batiaghata, Dumuria, Rupsha, Terokhada, Digholia, Fultala, and Metro Upazila in Khulna district (Figure-2). The highest rate was 20% in Koyra and the lowest was 2% in Rupsha. The total shrimp farming area is 45238, 47820, 49570, 53467 and 58472 in 2001-02, 2002-03, 2003-04, 2004-05 and 2005-06 fiscal year, respectively. The export volume and foreign currency earnings are encourage the shrimp farming.

Table 2: Increasing trend of shrimp farming area and Production in last five years in Khulna district.

Fiscal year	Production (ton)	Shrimp farming area (ha)	Increase index of area (%)
2005-06	21611	58472	29.25
2004-05	18986	53467	18.19
2003-04	16939	49570	9.58
2002-03	16080	47820	5.71
2001-02	14875	45238	0.00

Figure 3: Increasing Index (%) of shrimp farming area and production in Khulna region



The increase shrimp farming area and production are shown in Table-2. Increasing index of area in 2002-03, 2003-04, 2004-05 and 2005-06 are 5.71%, 9.58%, 18.19% and 29.25%, respectively, with the comparison year 2001-02 (Figure-3 and Table-2).

3.2 Employment generation and manpower distribution

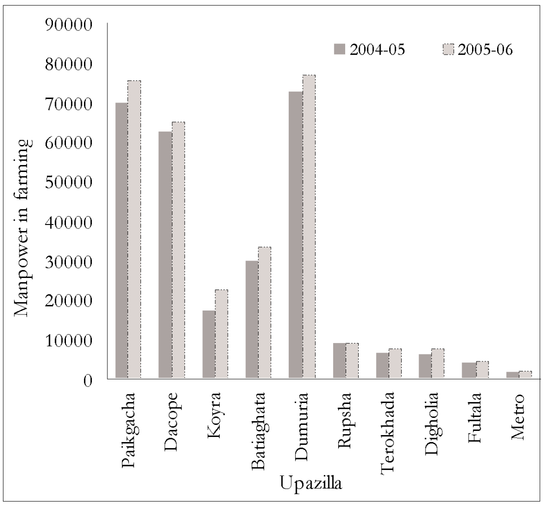
The initiatives of shrimp farming in *gher* system increase manpower involvement. The total manpower involved in shrimp farming was 279875 and 304570 in 2004-05 and 2005-2006 financial years, respectively. The maximum manpower involvements in shrimp farming were 69870 and 75460 at Paikgacha in 2004-05 and 2005-06, respectively, and the minimum were 1825 and 2110 at Metro Upazila in 2004-05 and 2005-06, respectively (Table-3 and Figure-4).

The total manpower involved in shrimp farming are 160585, 175850, 221780, 279875 and 304570 in 2001-02, 2002-03, 2003-04, 2004-05 and 2005-06 fiscal

Table 3: Upazila wise Manpower involvement in shrimp farming

Upazila	Manpower involvement in shrimp farming	
	2004-05	2005-06
Paikgacha	69870	75460
Dacope	62550	64890
Koyra	17250	22750
Batiaghata	29840	33410
Dumuria	72760	76925
Rupsha	8920	9170
Terokhada	6535	7645
Digholia	6195	7530
Fultala	4130	4680
Metro	1825	2110
Total	279875	304570

Figure 4: Upazila wise Manpower involvement in shrimp farming around 2004-05 and 2005-06 in Khulna district.



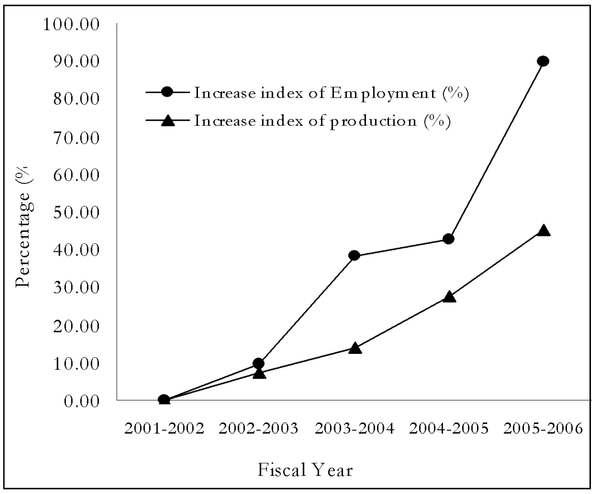
year, respectively (Table-4). Increases in the earning of foreign currency are creating huge employment generation in shrimp farming in the coastal belt of Bangladesh.

The indices of employment in 2002-03, 2003-04, 2004-05 and 2005-06 are 9.51%, 38.11%, 42.62% and 89.66%, respectively, with the comparison year 2001-02 (Figure-5).

Table 4: Employment generation in shrimp farming area in last five years in Khulna district

Fiscal year	Manpower involvement	Increase index of Employme
2001-2002	160585	0.00
2002-2003	175850	9.51
2003-2004	221780	38.11
2004-2005	279875	42.62
2005-2006	304570	89.66

Figure-5: Increasing Index (%) of Employment and shrimp production in Khulna region



3.3 Shrimp production from Khulna region

Total production of shrimp at Upazila level of Khulna district shows a phenomenal increase year by year. The cumulative production was always higher, viz., 14875, 16080, 16939, 18986 and 21611 tons in 2001-02, 2002-03, 2003-04, 2004-05 and 2005-06, respectively. In total production Paikgacha was always top producing 4453, 4790, 4948, 5645 and 5873 tons in 2001-02, 2002-03, 2003-04, 2004-05 and 2005-06, respectively, and the lowest production was in Metro Upazila at 30, 31, 36, 39 and 41 tons in 2001-02, 2002-03, 2003-04, 2004-05 and 2005-06, respectively (Table-5).

The production trend from 2001-02 to 2005-06 showed the highest deviation in Dumuria Upazila (± 778) and the lowest deviation in Metro Upazila (± 5) (Table-5 and Figure-6). The production deviation for the entire district was ± 1571, ± 1683, ± 1765, ± 2023 and ± 2023 in 2001-02, 2002-03, 2003-04, 2004-05 and 2005-06 fiscal year, respectively (Table-5 and Figure-7).The maximum deviation

Table 5 : Year wise production of shrimp and prawn in different Upazila in Khulna district of Bangladesh

Upazila	Production (ton)						
	2005-06	2004-05	2003-04	2002-03	2001-02	SD	Total
Paikgacha	5873	5645	4948	4790	4453	± 597	25709
Dacope	4388	3825	3356	3210	2935	± 572	17714
Koyra	1636	1532	1420	1380	1220	± 158	7188
Batiaghata	2145	1810	1642	1480	1302	± 323	8379
Dumuria	5416	4476	3950	3660	3486	± 778	20988
Rupsha	616	420	413	409	392	± 93	2250
Terokhada	582	535	510	503	488	± 37	2618
Digholia	569	418	386	372	344	± 89	2089
Fultala	345	286	278	245	225	± 46	1379
Metro	41	39	36	31	30	± 5	177
SD	± 2232	± 2023	± 1765	± 1683	± 1571	88491	
Total	21611	18986	16939	16080	14875		

is noticed in 2005-06 (± 2232) and the lowest in 2001-02 (± 1571) (Figure-7). Where, the production is high the deviation is high and vice versa. Market inconsistency, market demand, market competition and market price are mostly responsible for production variation.

3.5 Marketing Channel in shrimp trading

The trading pattern of shrimps business involves a series of intermediaries between the producers, suppliers, exporters and the consumers (Diagram-1). Generally the supply chain of shrimps is similar at all Upazilas in Khulna district. Farmers directly sell all their from *gher* to the local markets or to the shrimp traders or via foria to the shrimp traders. Shrimps traders collect shrimps from

Figure 6: Upzilla wise production variation in Khulna district in last five years

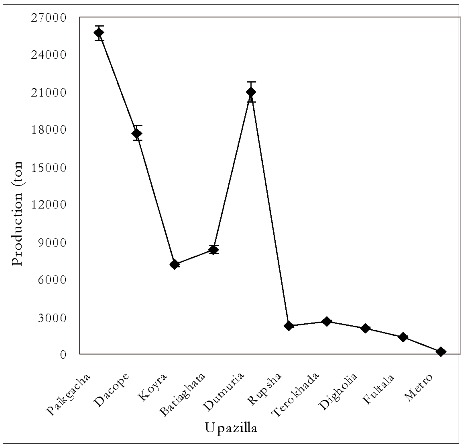
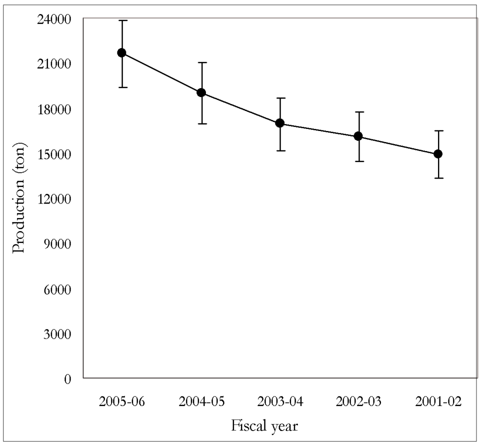
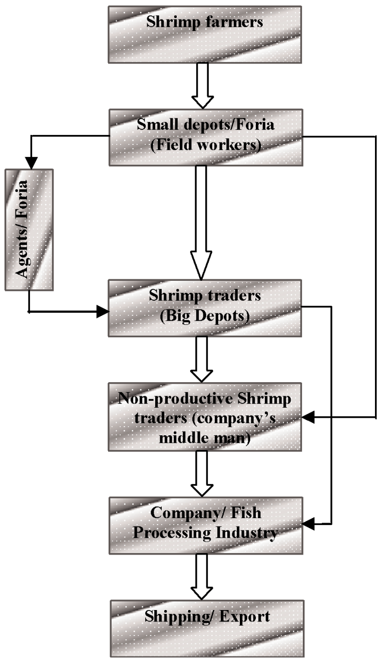


Figure 7: Year wise production variation in Khulna district



foria or shrimps farmers and supply them to the companies after 1 to 2 days preservation. Some people always work with the traders. Truck, pick-up and microbus are used for shrimp transport from traders to the companies. Bamboo made containers with polythene cover are used for keeping the shrimps. Some agents work between shrimps traders and companies. Companies are the warehouse factories for processing of shrimps. Finally companies export headless shrimps to the international markets through Mongla/ Chittagong port. A big chunk of the profit goes to middleman or brokers. Brokers act as middlemen between the harvesters and the exporters. The rejected Prawns and shrimps from depots and companies (under grade and broken legs or soft shell or discolored shrimps) are transferred to the local market for domestic consumption at low price.

Diagram 1: The pathway of shrimp distribution channel from harvesting to export



3.6 Major problems in Production and Marketing

Despite the great economic potential of prawns and shrimps in Bangladesh, the successful commercial shrimp production and marketing is hindered by different problems. The most crucial problems exist in Prawns and shrimps marketing and transportation, which can be categorized in the following way:

- Poor infrastructure facilities especially transport, ice factory, electricity etc.
- Lack of proper transportation system of prawns and shrimps from remote area to depot
- Lack of knowledge of proper marketing system and facilities
- Robbery/subscribing problems in rural and sub-city area
- Lack of consciousness/awareness about the right technique of prawns and shrimps culture
- The socio-economic status of the fishermen is so low that they cannot afford to make any big investment
- Supply of prawns and shrimps depends on foreign demand
- Lack of technical knowledge about shrimp grading, icing and processing
- Natural disaster and diseases are important obstacles for shrimp farming.

3.7 Key factors for sustainable shrimp farming

Although semi-intensive shrimp farming may be less detrimental to the environment than intensive systems of shrimp production, and less wasteful of land area than extensive farming, there are a number of factors on which the long-term sustainability of semi-intensive farming depends. The continuing high resource demands of such systems and their links to ecological degradation must be taken into consideration. The factors that should be considered to develop sustainable shrimp farming are the following:

- Availability of brood stock and efficient hatchery system to ensure predictable and steady supply of shrimp seed for grow-out operations.
- Suitable sites with quality water source, efficient drainage system and good infrastructure.
- Suitable farm design: construction and preparation for optimal water circulation treatment and storage of intake water, reconditioning and disinfecting of pond bottom, etc.
- Proper water management: pre-intake and discharge treatment, periodic exchange and aeration.
- Suitable stocking density considering the carrying capacity of the coastal culture environment.
- Nutrition: development of low-cost balanced feed, feeding management to avoid water pollution by feed waste accumulation.

- Shrimp health management: so far the best treatment and preventive measure against diseases is to maintain good water and pond bottom conditions.
- Farmer experience: consider new ideas from farmer's self-observation for development.

4. Conclusion

Bangladesh is a significant exporter of shrimp and well placed to develop and expand export market further. However, shrimp farming is still following traditional methods, except artificial stocking of shrimp post larvae. The country could not do much to increase production level up to expectation for lack of appropriate culture techniques. Most of the shrimp farms are unmanageably large having hardly exceeding 45 cm depth as against the required 1 meter, irregular shapes, uneven bottom, inadequate water supply and drainage system. Almost all fish markets operated by such traders, associations or cooperatives are very ill managed, unhygienic and unscientific. Since shrimp and prawn is a highly valued and highly demanded product in international markets, almost all shrimps are exported. It earns large amount of foreign currency. However, a sound trade infrastructure has not yet been established in Bangladesh. Government should take proper and advanced actions in infrastructure development such as road, transport, ice factory and banking system, and above all quality control must be developed in shrimp farming and marketing the product.

References

1. Ali, S. 1992. *Chingri, Bangladeshy Chingri Utpadon O Chash* (In Bengli). Publ. Bangla Academy, Dhaka, Bangladesh. 98 pp.
2. Ali, M.S., A.F.M. Shofiquzzoha and S.U. Ahmed (2000). "Observation on the production performance of *Penaeus monodon* with *Lisa parsia* under different cropping system". *Bangladesh J. of Fisheries*, pp141.
3. Bangladesh Bureau of Statistics (BBS), 1996. *Annual report published by Government of the Peoples Republic of Bangladesh*.
4. BFRI, 1996. Directorate of Fisheries. *Technologies and Development of Fisheries Resources*. Mymensingh. 260 pp.
5. DoF, 1998. *Matshya Pokko Saranica. Present status of Aquaculture in Bangladesh*.
6. Hoq, M.E., M.S. Ali and M.R. Saha and G.C Halder.1997. "Field evaluation of traditional shrimp farming in the south western region of Bangladesh". *J. Asiat. Soc. Bangladeah, (Sci).,*23(1); 21-27.
7. Hosmand, A.R., 1988. Statistical Methods for Agricultural Science, p 127-170 and p 251-278.
8. Hussain, M. M. 1994. "Status of Development of Fisheries and Sea Food Processing Industry in Bangladesh". In: M. A. Mazid, V.R.P. Sinha and M. Kamal (Editors), *Sustainable Development Marine Fisheries Resources in Bangladesh*. Proceeding of a workshop, Fisheries Research Institute, Cox's Bazar, Bangldesh. Pp. 65-85.
9. Karim, M., and Aftabuzzaman. 1995. *Brackish Marine Aquaculture: Potentials, Constraints and Management Needs for Sustainable Development*. A report of the National Workshop on Fisheries Resources Development and Management in Bangladesh. Organized by the Ministry of Fisheries and Livestock, Bangladesh in collaboration with BOBP/FAO and ODA- pp-119.

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June 2013, pp. 405-424
Bangladesh Economic Association
(ISSN 2227-3182)

Outbound Medical Tourism : The Case of Bangladesh

MUHAMMAD MAHBOOB ALI*

Abstract *Bangladesh is a least developed country and its health care management industry is miserably underdeveloped. Main reason behind underdevelopment of the health sector is inefficient human resources. Lack of efficient human skill in the health sector and level of corruption in this sector creates an explosive situation in Bangladesh. As such a good number of people per day is going to abroad for health treatment purpose. Research question of the study is whether people have been going other countries from Bangladesh due to inefficient human resources for treatment purposes? The study uses both primary and secondary data. Two questionnaires were administred to gather primey data for the period from July 2011 to November 2011. Analysis reueals observes that high costs, poor services, improper treatment and long waiting lists at home, new technology and skills in destination countries alongside reduced transport costs and Internet marketing have all played a pivotal role in the expansion of medical tourism from Govt. hospitals and health centers lacking basic health management skill. Private hospitals and nursing centers are also mostly engaged in earning super normal profit. But no systematic world class hospitals have been established in the country.*

Field of Research: *Health Care Management, Outbound Medical Tourism, Inefficient human resources, Bangladesh*

JEL Classifications:*I11, I15,015*

1. Introduction

Bangladesh is a densely populated country. Health care ought to be one of the basic privileges. According to Bangladesh Economic Review 2010, 990 persons

* Professor and Head, M.H. School of Business, Presidency University, Bangladesh and Chairman, Center for Breakthrough thinking in Bangladesh. E-mail.<pipulbd@gmail.com>

live in per/sq. kilometer. Unfortunately medical treatment is not easily available in Bangladesh for which each year a large nember of patients of the country visit foreign countries for medical ground. http://www.novasans.com/blog/2011/06/defining-medical-tourism/describes that medical tourism is a term involving people who travel to a different place to receive treatment for a disease, ailment, or condition, and who are seeking lower cost care, higher quality of care, better access to care, or different care than they could receive at home. A huge number of patients are govt. outside the country each year for medical purposes.

Most important health care services do not provide uniform right of entryand the marginalized people of rural as well as slum dwellers of the urban areas are treated in a highly discriminatory nature to access due health care lower middle class and middle class people do not also get proper treatment facilities. Moreover, maximum upper class people of the country do not trust health care supporting personnel including doctors, nurses. If there is no other alternative, then when seriously sick, the people of the country take are forced to treatment in the country.

Mahmud (2008) argues that the consumption of health care and the pattern of use of various kinds of health services are influenced a great deal by how health care is provided and factors related to the service delivery system, as well as the affordability of health care. There is evidence of very poor standard of public health care and weak provider accountability, contributing to the low quality of the public health care delivery system in Bangladesh. Mahmud's observation is quite convincing as patients and their relatives are worst victim since they don't get proper treatment in the country.

Ali and Medhekar (2012) opine that in order to improve the Bangladesh healthcare system ,the country has to face challenges from the growing global medical tourism in the neighbouring countries such as India, Thailand, Malaysia and Singapore. At the same time the Government of Bangladesh should take stps to enabls access to improved health care by its low and middle income group citizens and provide quality of care at an affordable price.

Medical Tourism is one of the fastest growing healthcare industries. The world is in a healthcare crisis, given the ageing population, increasing cost and long waiting period form patients from developed countries as well as from poor countries such as Bangladesh from whies more and impre patients traveling to relatively better developing countries or developed countries such as India, China, Singapore, Thailand, South Korea, Malaysia, KSA, USA, UK, Australia, Japan and Germany. with the main objective of obtaining immediate health care, plastic surgery, organ replacement and reproductive – IVF procedures in search of health care which is of best quality and the most affordable medical care, combining with related tourism activity such eco-tourism and spiritual.

This research study intends to deal with outbound medical tourism from Bangladesh due to inefficient human resources in health care management industry on the basis of a primary survey which not previously undertaken by researchers. This research intends to know the causative factors of outbound medical tourism. Huge amount of foreign exchanges have flowing out of the country from medical tourism purposes.

2. An Overview of Medical Sector of Bangladesh

Currently there are twenty-four public medical colleges and hospitals including Unani and Ayurvedic and Homeopathic medical colleges and hospitals in the country. In the private sector there are fifty medical colleges and Hospitals. Besides there is one University in the country. Recently some private medical hospitals with good quality were established. But their numbers are too scanty to meet the demands of a highly populated country. The world is in a healthcare crisis, given the ageing population, increasing cost and long waiting patients from developed countries as well as from poor countries such as Bangladesh. Low quality or absence of health care in these countries is compeling patients to travell abroad. Bangladesh Government has declared Health Policy but it remains inadequate and ineffective.

Health policies and strategies are not working properly. Actually the health sector of Bangladesh faces lack of good facilities both skilled manpower and physical infrastructure, ineffective and inefficient treatment, corruption in health management, high costs, politics among the health service providers, production of insufficient high quality drugs lack of inter sector cooperation, etc. Emergency preparation in the country is very much neglected ,organizational behavior of the health system in maximum hospitals and health centers is very much out dated, managerial process is not updated, community action is not properly developed, limited health research and technologies and the agenda of Reproductive Health including family planining program is not effective.

Daily Sun on 5th July, 2011 depicts that the HNPSP (2003-11) development budget, the share of GOB is 38% and that of Development Partners is 62%. The development budget, the share of the family planning, and maternal, child and reproductive health program is only 22% — 16% from GOB Development Budget and 25% from Project Aid. In the 2011-12 budget, only 5.4% has been allocated to the health sector — the annual per capita allocation in healthcare is only Tk. 590, i.e. a daily allocation of merely Tk. 1.62, not sufficient for attaining the MDG goal as well as Vision-2021 targets of the present government.

According to Financial Express (4th May,2012) Health Minister AFM Ruhal Haque on 3rd May,2012 called upon the local and foreign investors to set up industries for manufacturing medical and healthcare equipment and machineries in Bangladesh.

Financial Express 10th June 2012 observes that a section of unscrupulous hospital staff realizes money from helpless patients either for providing a trolley or allotment of a seat. In some hospitals, it is alleged, 'Dalals' allure patients to go to clinics on the assurance of receiving better treatment. A section of doctors and hospital staff who are associated with those particular clinics try to convince the patients for their own interest to earn extra money. Moreover, medicines supplied to those public hospitals find their way into the outside shops for sale. Such practices are not new. These are continuing unabated for years. The powerful groups among general staff having political connections are mainly responsible for this evil practice.

Wrong treatment and bad behavior and greediness of doctors, nurses and ward boys and support staff have been crippling this sector. Under government initiatives hospitals, helath centers etc. a nexus of rampant corruptions has been created an hospitals and health most doctors are divided into two distinct political party affiliations. Moreover, investors and management of private sectors hospitals, nursing homes, diagnostic centers etc. treat this sector as a "money making machine". Though there are some good hospitals in private sector they are too much expensive in relation to per capita income of the people. Sometimes these hospitals act like Stars of BCG matrix. Even some specialized doctors per month by income of Tk.1 to 1.5 crore through private practice. Health information system and prevention system are not of good quality. Actually there are several reasons of these problems but the main reason behind this problem is lack of human resources. Receivers the health services are not happy. Chronic disequilibria between service providers and service receivers in the health sector prevail. This study mainly wants to identify the efficiency level of human resources of the health sector as it is very much vital.

http://expertscolumn.com/content/medical-and-health-sector-bangladesh-are-threat comments that not only in the rural area but also in the urban cities the people are not getting quality treatment. There are not many pecinlist in the whole country who can diagnosis the problem and can make the best treatment. People also gather to those doctors but because of the huge pressure doctors are not in a position to treat all the people who came to the doctor. The diagnostic centers are also not so quality who can make the report 100% correct. Though there are some good diagnostic centers who test the reports well but most of the diagnostic centers are not serious about their task.

Ara(2008) observes that the health care system in Bangladesh is operating within a complex political administrative environment. The politicized administrative structure which lies at the root of our mis-governance reflects governance failure in the health sector. She suggests that existing policies need to be reviewed and revised for improving accessibility, affordability and quality of services and for further improvements in affordability, quality and safety of drugs and rational use of drugs. New policies on public and private sectoral mix and financing of services need to be formulated, protection and preservation of the environment; more training institute for graduate and postgraduate study with proper practical facilities should be established and the development of a comprehensive people oriented plan to improve and assure the quality of health services should be enscekped.

Table 1: The Present situation of the Health Sector

Sl.No.	Present situation	2008-09
1	No. of Hospitals in Health sector	589
2.	No. of non-Govt. Hospitals (Numbers) Registered	2271
3.	No. of beds in Health sector	38171
4.	No. of beds in Private sector (Registered)	362444
5.	No. of registered Physicians (April 2009)	49994
6.	No. of Registered dental surgen (April 2009)	3451
7.	No. of govt. medical colleges	18
8.	No. of Private medical colleges	41
9.	No. of private dental colleges	11
10.	No. of private institute of Health Technology	39
11.	No. of Doctors under Health services	12382
12.	No. of registered nurses (as on April-2009)	23729
13.	No.of registered Mid-wives	22253
14.	No. of trained skilled birth attendance	5000
15.	Population per Physicians	2860
16.	Population per bed	1860
17.	Physician to Nurse Ratio	2.1
18.	Population per nurse	5720

Source: *Bangladesh Bureau of Statistics (2011), Statistical Pocket Book of Bangladesh p-375*

Table 1 indicates the pitiable statr of theeountiys health sector. The doctor-patient ratio or nurse-patient ratio or physician per nurse ratio is very low. Even population per bed is also low.

3. Literature Review

Johnson (2000)comments that in health sector reform the role and core functions of the public sector shift from a primary focus on the direct provision of personal health services to a more clearly articulated normative role that combines health needs assessment and surveillance, policy making, regulatory financing functions with the assurance of the delivery of quality personal health services and population based services.

Hossen (2001) suggests that for better health care practices, partnership is required between sectors, institutions, communities, organized interest groups ,and individuals to work together in harmony and cooperation on the basis of mutually agreed principles and objective.

Noe et al. (2003) comment that human resource management functions that have been heavily involved in transactional activities for a long time tend to lack systems, processes, and skills for delivering state-of-the-art traditional activities and are thoroughly unable to contribute in the transformational arena.

Hongoro and McPake (2004) argue that human resources are in very short supply in health systems in low and middle income countries compared with high income countries or with the skill requirements of a minimum package of health interventions. Equally serious concerns exist about the quality and productivity of the health workforce in low income countries. Among available strategies to address the problems, expansion of the numbers of doctors and nurses through training is highly constrained. This is a difficult issue involving the interplay of multiple factors and forces.

Huque and Bhuiyan (2005) argue that in the developing countries, the key elements of Health sector reforms are the promotion of the private sector, changes in the internal structure and operation of the public sector and changes in the financing of health care. Health sector reform is also an important policy agenda of Bangladesh. Young(2005) comments that as health systems operates in an environment of scarce resources, effective programs still need to be justified in terms of economic efficiency, which can be demonstrated by means of cost-effectiveness, cost-benefit ,and cost-utility analysis. These types of economic evaluations all relate costs to consequences, but differ in how consequences are measured: as health effects, in monetary units, or in quality-adjusted life years, respectively.

Lee(2006) argues that Asian countries have a competitive advantage in the emerging healthcare industry. There are medical enterprises in countries such as

India, Thailand, Singapore and Malaysia that have invested in attracting tourists for this specialist market.

Kabene, Orchard, Howard, Soriano and Leduc (2006) argue that proper management of human resources is critical in providing a high quality of health care. A refocus on human resources management in health care and more research are needed to develop new policies. Effective human resources management strategies are greatly needed to achieve better outcomes from and access to health care.

Kunitz (2007) observes that it is still accurate to say that while openness has not resulted in the benefits promised by the optimists, neither has it had deleterious consequences for the health of many populations that the pessimists predict.

Lee and Spisto (2007) argue that as an international business, medical tourism is not too different from the subcontracting or the off-shoring of services. With higher costs and expertise, in the future, medical tourism is likely to be the new global trend for providing medical services.

Salahuddin and Nisar (2007) suggest that in Pakistan developing a proper remuneration system for the doctors of public sector within the country important so that the problem like brain drain, wastage of time energy and resources of public health sector could be solved.

Tattara (2010) argues that Medical tourism in poor countries is strictly interlinked with the health privatization process and the ability to provide excellent treatment to some sectors of the population, not caring for the performance of the whole system.

ADB (accessed in the website -2011) observes for Vietnam is that the overall constraints in health human resources are poor skill levels, the mal-distribution of the workforce across rural and urban areas and across the public and private system, and low pay and poor incentives for workers. Policy and investment support for better quality pre- and in-service training will improve skills and service capacity and thus the effectiveness and technical efficiency of the health sector workforce in the medium to long term.

Islam and Akther (2011) observe that despite limited success in producing financial sustainability, quality and equity in government health services, user charges remain a vital strategy and a popular option for health care financing reforms.

Padmanabhan (2011) describes that from Greeks visiting Epidaurus to Romans immersing themselves in the healing waters of Bath to 19th century Europeans flocking to spa towns and sanatoria, people have traveled long distances hoping to restore their health for millennia. What is new is that, in spite of the existence of excellent local medical care in their countries of origin, many medical tourists residing in richer countries are simply unable to access what is right next door. The sphere of health care has been transformed by private, for-profit interests, where price and private insurance schemes reign and dictate who has access to treatment, surgery and medication and who does not.

Pocock and Phua (2011) examine that travelling overseas for medical care has historical roots, previously limited to elites from developing countries to developed ones, when health care was inadequate or unavailable at home. Now however, the direction of medical travel is changing towards developing countries and globalization and increasing acceptance of health services as a market commodity have led to a new trend; organized medical tourism for fee paying patients, regardless of citizenship, who shop for health services overseas using new information sources, new agents to connect them to providers, and inexpensive air travel to reach destination medical .

Snyder, Dharamsi, and Crooks (2011) argue that if medical tourists have a social responsibility to look to the efficient functioning of their own domestic health systems, then participation in medical tourism will extend this responsibility to the health systems of the destination countries to which they travel and develop new connections. Medical tourism for procedures that will serve to undermine health equity and the sustainability of the health system in destination countries is therefore a potential violation of the patient's social responsibility. Crucially, however, many of the worries about the negative impacts of medical tourism on destination countries are matters of conjecture rather than well-established fact.

Turner (2011) depicts that despite the rapid expansion of the medical tourism industry, few standards exist to ensure that these business organize high quality competent international health care. Standards should be established to ensure that clients of medical tourism companies make informed choices. Country of care needs to become an integral feature of cross-border care.

Vijay (Access in the website 2011) the Indian tourism industry is now promoting medical tourism as a novel hope for the Indian economy. Five-star hospitals are mushrooming around the nation and major investments by big corporate players are expected. The privatisation and 'corporatisation' of health care has created medical tourism where people from rich nations travel to Third World countries to obtain medical care, experience and enjoy the tourism attractions and use other resources. It is a 'magic lamp' for those countries to attract overseas patients and earn foreign exchange.

Waikar, Cappel, Tate (2011) says that argue that to promote medical tourism, the host country can undertake improvements in infrastructure, transportation, security etc. The host country government can look at not just the number of medical tourist visiting the city or the region but their net economic impact on the city or the region. Then, the "A-B-C analysis" approach in operations management can be employed to create category "A" category "B" and category "C" cities or regions with highest priority going to category "A" listing. Priorities established then can be used for allocation of resources for improving infrastructure, facilities, and tourist spots, and for improving security and safety of visiting medical tourists. The eventual goal should be to cover cities and regions in all three categories.

Aforesaid literature review indicates that most of the researchers' have done work in other countries than Bangladesh. As a result the number of the sort of research works in Bangladesh was very scanty. But health care and services are most important factor for the people. It is one of the basic needs. As such based on aforesaid literature review, we have undertaken following objectives and research methodology.

4. Objectives and Research Methodology

The study has been undertaken with following objectives:

i) To evaluate the overall efficiency of Personnel in Healthcare Management of Bangladesh;

ii) To examine reasons behind outbound medical tourism;

iii) To provide some policy implications for medical tourism sector of the country. Research question of the study is whether patients are going to other countries from Bangladesh for lack of in efficiency of personnel in the country's Health care Management. The answer is, we assume, that healthcare services in Bangladesh are not efficient. The study collects data and information from both primary and secondary sources.

A questionnaire was prepared and distributed to 611 persons randomly, out of which 500 persons responded. The sample size is low due to the fact that the time period limited and the cost in data collection was also high. Previously a scanty research work was done this subject but the persent study has tried to find out the reason behind outbound medical tourism. A field survey will also be done at the Gonoshasthaya Samajvittik Medical & Dental College under Ganashastya University. Time period of the study was from July 2011 to November 2011.

On the basis of these questionnaires, regression analyses were conducted. We use SPSS to determine descriptive study data accurately and regression analysis. Moreover, the study also did some qualitative judgments and intervi at field level survey. In our study the dependent variable is Efficiency of Personnel in healthcare management, while independent variables are Staff Group (includes Training and development; Recruiting policy; Quality of services; Compensation and Non compensation), and Patient Group (includes Good services, Caring abilities, Pricing). This paper, therefore, finds some objects for staff group such as training and development, quality of service, recruiting policy work as an independent variable and good service, caring abilities and pricing work as an independent variable of patient group for Efficiency Personnel of the Health care Management to provide better medical services in the country. The model is shown in Figure:1.

From the service providers we choose Staff Group. Staff group consists of *Training and development (*Staff_T_D)*, Recruitment Policy* (Staff_Recruit)*, Quality Service (*Staff_qua_ser), Compensation and Non compensation (Staff_comp_ncomp).

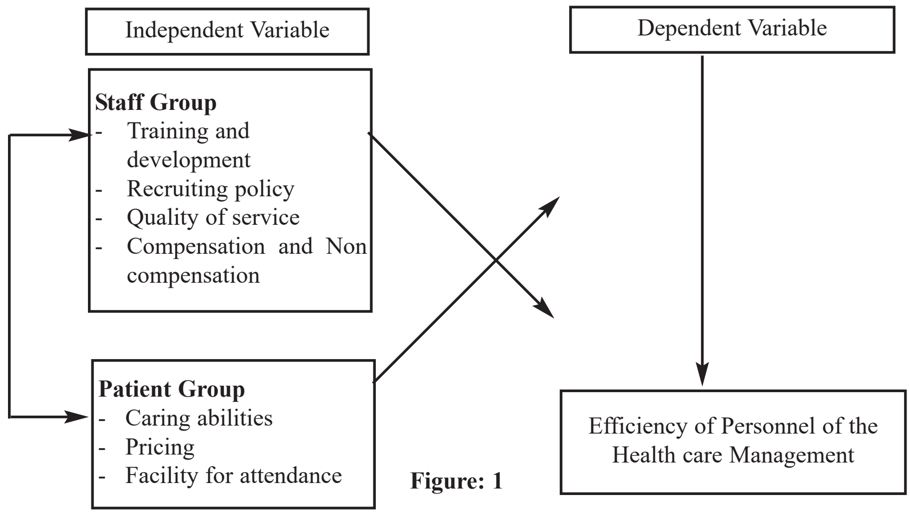


Figure: 1

For the demander side we choose patient group. Patient group consists of facility for attendance (Patient_Atce); Caring abilities (Patient_Cari_abi), Pricing(Patient_Price).

5. Hypothesis Testing

Ho: Overall efficiency of Personnel in Bangladesh Health care management does not prevail which leads to increase outbound medical tourism from Bangladesh.

Ha: Overall efficiency of Personnel in Bangladesh Health care management prevails which isn't related to increase medical tourism from Bangladesh.

6. Analysis of Findings (Quantitative)

Result of descriptive statistics has been given below:

In Table:1, mean value of all the Independent and Dependent Variables between 3.60 to 4.2 so it indicates sampling people agree with our most of the questionnaire on health care sector, and the Standard deviation indicates that the

Table 2: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Staff_T_D	500	1.75	5.00	3.5975	.72399
Staff_comp_ncomp	500	1.00	5.00	4.1150	.95241
Staff_qua_ser	500	1.25	5.00	3.9765	.84676
Staff_Recruit	500	1.50	5.00	3.6305	.59143
Patient_Atce	500	1.75	5.00	3.8670	.70821
Patient_Cari_abi	500	1.50	5.00	3.6280	.66029
Patient_Price	500	1.25	5.00	3.8530	.85666

data points are far from the mean because sampling group of people has different thoughts. If it is small standard deviation than it indicates they are clustered closely around the mean.

7. Reliability

Reliability test persented in Table 3 indicate the Independent variables are highly related to the underlying dependent variable.

Table 3: Case Processing Summary

		N	%
Cases	Valid	500	81.8
	Excluded(a)	111	18.2
	Total	611	100.0

a List wise deletion based on all variables in the procedure.

In Table: 3, Cronbach's alpha is a coefficient of reliability. It is commonly used as a measure of the internal consistency or reliability of a psychometric test score for a sample of examinees. Here Cronbach Alpha value is more than 0.7 which is an acceptable value for internal consistency or reliability of the test

Table 4: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.757	.730	8

8. Regression Analysis

F –statistics is significant at 1% level. Difference between R square and adjusted R square is quite okay. Adjusted R-squared is 0.616, which indicates that the equation provides a moderate fit.

In the regression equation, all the variables are significant. Staff Compensation

Table 5: Model Summary

R Square	Adjusted R Square	Std. Error of the Estimate	F-Stat.
.6267	.6160	.68367	38.17364

and Non compensation is significant at 1% level. Staff quality services are also significant at 1 % level. Staff training and development is also significant at 1% level. Recruitment Policy is significant at 10% level of significance.

Table 6: Estimated results of the regression equation

VARIABLE	COEFFICIENT	t-STATISTICS	PROB.
C	3.427461	7.975067	0.0000
Staff_T_D	0.724549	6.253381	0.0004
Staff_comp_ncomp	0.810758	8.569812	0.0000
Staff_qua_ser	-5.362317	-2.801366	0.0105
Staff_Recruit	1.410225	1.2712044	0.0847
Patient_Atce	0.675582	1.883297	0.0841
Patient_Cari_abi	0.460879	3.592275	0.0012
Patient_Price	0.512611	5.012241	0.0001

On the other hand, patient pricing and caring abilities are significant at 1% level of significance. Facility for patients attendance is significant at 10% level.

9. Quantitative Analysis

The study observes that the null hypothesis is acceptable. The overall efficiency of Personnel in Bangladesh Healthcare Management does not prevail .This deficiency creates medical tourism from Bangladesh abroad and huge amount of foreign exchange outflow from the country.

It is observed that out bound medical tourism rose due lack of efficient and effective health care system, Doctor-nurses ,brothers, biotechnologists and ward boys were not providing desirable services to the patients and allegations against diagnostic centers caused of faith in local hospitals. Another interesting findings of the study is that most of the diagnostic centers and lab tests are charging high

Table 7:

OUTWARD REMITTANCE TO		**INDIA (million US$**
Year	**Total Remittance**	**Medical**
1986 -87	18.93	0.03
1987-88	19.05	0.02
1988-89	18.58	0.02
1989-90	24.4	0.01
1990-91	19.36	0.01
1991-92	19.1	0.03
1992-93	20.08	0.05
1993-94	27.77	0.17
1994-95	33.01	0.23
1995-96	25.69	0.24
1996-97	37.1	0.29
1997-98	32.29	0.44
1998-99	25.96	0.17
1999-2000	33.06	0.21
2000-01	34.3	0.38
2001-02	16.06	0.2
2002-03	17.21	0.29
2003-04	18.88	0.28
2004-05	22	0.26
2005-06	17.04	0.23
2006-07	19.61	0.13
2007-08	28.07	0.24
2008-09	81.89	0.39

Source: *Statistics Department, Bangladesh Bank,2010* which is relatively one-third in India in any good Institute as reported by the respondents. Reason behind low price in India is that there is no system of giving percentage or bribe. Moreover, problems of attendances are also working as one of the causative factors to travel outside the country.

High costs, poor services and long waiting lists at home; innovative technologies and expertise's in target countries alongside reduced transport costs and Internet based communication have all played a pivotal role in the expansion of medical tourism from Bangladesh to abroad.

Depending on income and nature of diseases, patients visit different countries. As such huge amount of fund flows out of the country. Depending on financial ability as well as connectivity and visa facility, patients along with attendance go to various counties like USA, Canada, Australia, UK, Thailand, South Korea, Malaysia, Saudi Arabia, Singapore and India. However, lower middle class and middle class patients have been going to India for treatment purposes. Table 7 data on outward remittance on medical ground to India and also total remittance from Bangladesh from the year 1986-87 to 2008-09:

Unofficially march more amount flows out from Bangladesh for health leadment. All the respondents informed that they did not declare the amount in order to avoid tax or harassments. In special cases they go to bank for remitting fund on health ground.

The growth of medical tourism is an important export sector in India .India's National Health Policy which declared that treatment of foreign patients is legally an "export" and deemed eligible for all fiscal incentives extended to export earnings. This helps to ensure good quality of medical treatment in India. Most of the Bangladeshis are going there as they are getting relatively better treatment at an affordable cost which is not feasible in Bangladesh. In our survey of 500 patients most respondents told us that nurses, brothers and ward boys act like mussel. It is evident the study that in most cases nurses, brothers and ward boys in do not care doctors and avoid providing good services in different govt. medical hospitals and health centers. Moreover, most doctors' in govt. hospitals are engaged in politics supporting actively the two big political parties for getting good posting as well as other facilities in the regime of the party in power and also getting shelter for rampant corruption. They even forget to do welfare of the patients. There is no accountability for wrong treatment in the country as observed by the respondents' comment.

In private medical colleges, specialised hospitals, health centers and nursing homes/centers services are not at all satisfactory either. Rather they charges huge amount of money without ensuring good treatment and quality services. Quality of medicine is also a problem for Bangladesh. Patients complained that that due to the absence proper monitoring some companies are produeing lower quality medicine and doctors bribe from low graded medicine companies to prescribed these lower quality medicines.

Patients also commented that they found with utter surprise that the number of diagnostic centers Bangladesh is 2/3 times higher in India. When we verified it from 5 good diagnostic centers situated at Dhaka City and Chittagong City they told that they have to pay 25-45% commission to the Doctor who refered them to the patient. Moreover, it is alleged specialised doctors are used to see 80-200 patients on an average per day. As a result they cannot give much time to the paticnts. Moreover, monthly income of a few specialized doctor is from Bangladesh Taka 1 crore to 1.5 crore. Another complain from the patients is that a lot of pathological reports in Bangladesh differs from those of quality diagnostic centers abroad.

Private medical colleges charge admission fee for studying MBBS from 0.9 to 1 Million Bangladesh Taka and when a person finishes his/ her MBBS degree he/she has to pay 3-6 Million Taka. So when a student becomes doctor a his/her attitude is to raise income at any cost. Moreover, admission criteria are not up to the mark. The eviteri doe not favour students who come from “O” level and “A” level but help those who come from Bengali medium schools. This prevents to get good quality students. As such those passed with Physics, Chemistry, Biology and Math with “B” grade at “O” level and any three aforesaid subjects at “A” level with “B” grade should get preference to get admitted in MBBS program of Bangladesh.

Moreover the number of specialised doctors is small. Furthermore, patients allege that in Bangladesh in rare cases actions may be taken against doctors but no action has ever been taken against nurses, brothers, ward boys for their negligence of duties. There is a nexus of corruption in the health sector.

Patients who come from different corners of the country to the Dhaka city for medical purpose suffer from residense problem as well as security and safety problem. There are middlemen in the govt. hospitals that suck poor patients’ money. Bangladeshi patients travell to India for medical tourism not receive basic medical treatment in Bangladesh. Criminalization and corruption among some doctors are such that they even do different sorts of business and active politics which greatly hamper treatment. Even one ex director general of Health services was allegedly involved in occupying a garage through using muscel power and cartel with some persons at Dhanmondi residential area of Dhaka under the banner of the apartment society. If unethical practice is done a person who served as a Director General of health services and who is still working as a Professor of a Govt. Medical college then what sort of treatment one can expect from such doctors?

According to a report published in Bengali Daily Kalayer Khanta (30th April, 2011) as per World health Organization's guidelines the ratio of doctor and nurse should be 1:3.But in Govt. hospitals of Bangladesh where the number of registered doctors is 12359, the number of nurses is only 14338.Moreover, in govt. hospitals total number of posts of nurses are 16,969 while 2020 posts are still vacant. In the private sector, total number of registered physicians is 51,993 and then of registered dentists is 3913, but the total number of registered nurses is 26899.There is a huge deficit in nurses in Bangladesh. As such patients are not getting proper services.

This study through field survey also observed that Ganashastya University has a medical college and also gives training to the nurses. But in most cases they do not issue certificate to the nurses and as such after learning 3-4 months, most of the student nurses whom they call worker the organization and work in different private clinics. Gonoshasthaya Samajvittik Medical & Dental College does not normally appoint any ward boys, which creates tremendous hindrance to getting good services especially for male patients or overweight female patients. Gonoshasthaya Samajvittik Medical & Dental College's pay structure is very low and as such their retention of qualified doctors, nurses or workers is very poor. Though the hospital tries to provide services to poor people in different areas through its health centers the treatment and health related services are very poor worse than remote govt. health centers or govt. hospitals. From the field study it is observed that Gonoshasthaya Samajvittik Medical & Dental College needs proper managerial skill and compensation packages for their doctor, nurse and other staff.

Govt. of Bangladesh has recently declared a Health Policy. But it needs to be holistic nature. Only giving more emphasis on Doctors duty is not sufficient as other related services such as nurses, brothers, biotechnologists and ward boys and moreover hospital management are weak in Bangladesh. As such huge amounts of money flow out of country for treatment purpose.

Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM) is working for long time but their standard is decarging by day. Bangabandhu Sheikh Mujib Medical University (BSMMU) is the only medical University of the country but it is not providing up to the mark of international standard benchmarking services. This author observed personally in BSMMU in the year 2005, during his father's treatment for around 40 days how nurses were gossiping with young doctors in the intensive care unit of the cardiovascular department. None is there to take action against them. Individualistic attitude and personal gain is the key factor for doctors and nurses and specialst doctors neglect the patients.

Recently some good Hospitals have been established like Apollo, Square, United, Lab Aid, Popular, Sikder Medical college hospital etc in Dhaka city. But the number of good hospitals and diagnostic centers are too scanty to the highly densely populated country like Bangladesh where according to UNICEF report (2010) 16.4 crore people Live. Some good private hospitals were also established in Chittagong, Sirajgong etc. From the study it is evident that public hospitals are lacking basic health management skill. Private hospitals and nursing centers are also mostly engaged in earning super normal profit. But no systematic world class hospitals population density have been established in Bangladesh.

11. Concluding remarks and Policy Implications

The government may put emphasis on the development of the health sector of Bangladesh. It may encourage establishing joint venture medical colleges in collaboration with foreign medical institutes/colleges. Moreover, private entrepreneurs can invest in this sector as it still remains an unexplored market. Besides, the number of doctors, quality and dutiful nurses, brothers, biotechnologists and ward boys need to be increased and management should be improved. Health care management can be improved through strategic formulation and implementation of government policy. Career path of young doctors should be properly redesigned. Moreover, social prestige of nurses in the society should be upgraded. Corruption in government as well as private hospitals should be removed. False doctors should get proper punishment. Quality maintenance of drugs should be ensured. Diagnostic centers should stop bribing processes.

Hongoro and McPake (2004) observation that human resources are in very short supply in health systems is applicable in Bangladesh. As such there is no other alternative but to take holistic approach to develop this sector. Medical tourism in Bangladesh may be developed as part of Vision 2021.

Turner's (2011) caution about maintenance of standards should be perused with care in order ensure that patients and their associates get proper information of medical tourism for taking appropriate choices. There are no other alternatives but to maintain quality assurance in this sector.

Outbound medical tourism arises due to lack of efficient and effective health care system. In this connection Hossen (2001) suggestions for better health care practices, partnership between public and private sector may be arranged.

Private Universities except Gonoshasthaya Samajvittik Medical & Dental College under Ganyo Shasthya university of the country should come forward to open different sorts of education related to Medical science courses. Some private universities have opened only Master in Public health course. Even physiotherapy course cannot be given permission to open or continue in private medical Collages by the Health ministry.

Not only decreasing outbound medical tourism but also increasing inbound medical tourism in Bangladesh may be a part of Vision 2021 by the government of Bangladesh when the country will observe fifty years of independence of the country. Govt. expenditure in the health sector should be raised to achieve millennium development goal. Inbound Medical tourism should be declared as a thrust export sector in Bangladesh and availability of all sorts of medical care at a low cost and maintaining quality assurance must be ensured as a top priority, in mid and long term planning. Contingency planning for developing health care industry should be properly implemented. This will help save valuable foreign exchange through decreasing outflow of foreign exchanges due to outbound tourism. Moreover in the inflow of foreign exchange earnings from inbound medical tourism in the country will help accelerate growth of national income of the country.

References

1. ADB 2011, “Economic Analysis Health Human resource sector development program”, (RRPVIE 40354-01), http://www.adb.org/Documents/ RRPs/VIE/ 40354/40354-01-vie-ea.pdf (access on 23rd June the website, 2011)
2. Ali, MM and Medhekar, A 2012, “A Cross-Border Trade in Healthcare services: Bangladesh to India, *Presidency University Journal*, Vol. 1, No. 1, January.
3. Ara, F 2008), “Key Issues to Health Governance in Bangladesh”, Paper to be presented at the International Conference on ‘*Challenges of Governance in South Asia*’ in Kathmandu, Nepal, December 15-16.
4. Bangladesh Bureau of Statistics (2011), Statistical Pocket Book of Bangladesh p-375
5. Cundiff, KR 2008, ”Life Expectancy, Health care, and economics”, *Southwest review of International Business,* Vol. 19, No. 1, March, pp. 145-149.
6. Daily Kalayer Khanta 2011, 30th April
7. Financial Express (Bangladesh) 2012, 4th May
8. Financial Express (Bangladesh) 2012, 10th June
9. Haque, R and Bhuiyan, S M 2005, ”Recent Debates on Heath Sector reforms: Some reflection on Key policy issues”, *Social Science Review, The Dhaka university Studies*, Part-D, Vol. 22, No. 1, June, pp. 131-146

   http://expertscolumn.com/content/medical-and-health-sector-bangladesh-are-threat (accessed on 14th March,2012) http://www.novasans. com/blog/ 2011/06/ (accessed on 25th October 2011)
10. Hongoro C, McPake B *2004,* “How to bridge the gap in human resources for health”, *The Lancet* , Vol. 364, pp. 1451–56
12. Hossen, MA 2001, ”Beliefs and Practices relating to health care in Developing countries”, *Social Science Review, The Dhaka university Studies*, Part-D, Vol. 22, No.1, June, pp. 247.-256.
13. Islam, A and Akhter, S 2011, ”Introducing User charges in Government Health facilities in Bangladesh: Policy and Implementation”, Social *Science Review, The Dhaka university Studies*, Part-D, Vol. 28, No. 1, June, pp. 43-56.
14. Johnson, S 2000, ”Building Capacity In Human Resources Management For Health Sector Reform And The Organizations And Institutions Comprising The Sector”, the LAC Health Sector Reform Initiative by the Family Planning Management Development Project (FPMD), a project of Management Sciences for Health (MSH) in Boston, Massachusetts.
15. Kabene, SM, Orchard, C, Howard, JM, Soriano, MA and Leduc, R 2006, “The importance of human resources management in health care: a global context, http://www.ncbi.nlm.nih.gov/pubmed/16872531 Kanchanachitra, DC et al. 2011,”
16. Kunitz,SJ 2007, *The Health of Populations-General Theories and Particular Realties*, Oxford University Press, Inc. New York, pp.135-185

17. Lee, C 2006, Medical tourism, an innovative opportunity for entrepreneurs, *Journal of Asia Entrepreneurship and Sustainability*, Volume III, Issue 1, pp. 110-123

18. Lee, C, Spisto, M 2007, "Medical Tourism, the Future of Health Services", 12-ICIT 9-11/4/07 in RoC Going for Gold ~ Best Practices in Ed. & Public Paper No. 07,p.1-7

19. Mahmud, S 2008, "Health care provision and Consumption in Bangladesh" in "Emerging issues in Bangladesh Economy- A review of Bangladesh's Development 2005-06', Rehman Sobhan (Series Editor), Center for Policy Dialogue and The University press Limited, pp. 323-359.

20. Vijay NM 2011, "Medical tourism - Subsidising health care for developed countries"; http://www.twnside.org.sg/title2/resurgence/207-208/cover9.doc *(accessed in web 2011)*

21. Noe, RN et al. 2003, *Human Resource Management-Changing a competitive advantage*, McGraw-Hill-Irwing, Boston, 4th edition, pp. 656-663

22. Padmanabhan, A, 2011, A Study of the Phenomenon of Medical Tourism with in the Context of the General Agreement of Trade in Services (GATS), SSRN-id1941709, pp.1-21,

23. Pocock, NS and Phua, KH 2011," Medical tourism and policy implications for health systems: a conceptual framework from a comparative study of Thailand, Singapore and Malaysia", *Globalization and Health*, pp.1-12

24. Salahuddin,T ad Nisar, MY 2007, "Comparing incentives and productive efficiency in Government health services: A suggestion document for Government of Pakistan, 9th South Asian Management forum, Proceedings organized by North South University, Dhaka and South Asian association for regional cooperation, 24-25 February, pp. 447-453.

25. Snyder, J, Dharamsi, S and Crooks, VA 2011, "Fly-By medical care: Conceptualizing the global and local social responsibilities of medical tourists and physician voluntourists", *Globalization and Health*, http://www.globaliza tionandhealth.com/content/7/1/6

26. Tattara, G 2010, "Medical tourism and domestic population health". Working Papers, Department of Economics, C A ' Foscari University of Venice No. 0 2 /WP/2010, pp.1-16

27. Turner, L 2011, "Quality in health care and globalization of health services: accreditation and regulatory oversight of medical tourism companies." *International Journal for Quality in Health Care,* December, Vol. 23, pp. 1-7

28. Waikar, AM, Cappel, SD, Tate US 2011," Challenges and Opportunities for Developing Countries from Medical Tourism", *Journal of Business and Economics*, Volume: 2, No. 5, pp. 325-331

29. Young, T. Kue 2005, *Population Health-Concepts and Methods*, Oxford University Oress, Inc., New York, 2nd edition, pp.296-323

Bangladesh
Journal of
Political
Economy

Vol. 29, No. 1, June, 2013, pp. 425-437
Bangladesh Economic Association
(ISSN 2227-3182)

Some Determinants of CO_2 Emissions in Bangladesh

PRASHANTA KUMAR BANERJEE*
MATIUR RAHMAN**

Abstract *CO_2 emissions, industrial output growth, population growth and Foreign Direct Investment (FDI) inflows in Bangladesh for 1972–2008 are found non-stationary in terms of both Augmented Dickey– Fuller (ADF) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests with different orders of integration. As a result, the Autoregressive Distributed Lag (ARDL) model and Vector Error-Correction Model (VECM) are estimated. There is evidence of a co-integrating (converging long-run equilibrium) relationship between the variables of long-run causal flows from industrial output growth, population growth and FDI to CO_2 emissions. FDI seems to marginally mitigate CO_2 emissions. Furthermore, short-run interactive net positive feedback effects among the variables are also evidenced.*

1. Introduction

Among a multitude of environmental pollutants, carbon dioxide (henceforth, CO_2) emission is a serious problem in developing countries. This increases at an early stage of industrial expansion as a transition from overdependence on agriculture. Such industrial transformation is heavily dependent on energy intensive technologies. They consciously allow foreign pollution intensive firms to migrate from developed countries where environmental standards are comparatively much higher, which results in high regulatory compliance costs of production. The motivation is to entice Foreign Direct Investment (FDI) for job creation to end abject poverty which is an

* Professor, Bangladesh Institute of Bank Management, Dhaka, Bangladesh, Email: banerjee1167@gmail.com

** Professor, Department of Accounting and Finance, McNeese State University, Lake Charles, LA 70609, USA Email: mrahman@mcneese.edu

outcome of rising income inequality. Moreover, the degree of environmental awareness is very low in developing countries.

Once a developing country's per capita real income approaches a certain level, the country gains resources to invest in costly environment friendly technologies to mitigate the level of CO_2 emission. As a country's economic structure later gradually transforms from manufacturing to the expanding services sector, CO_2 emission continues to abate. Meanwhile, people become increasingly environmentally conscious for health reasons and continue to press the home country government to raise environmental standards. This phenomenon is described by Kuznet's inverted environmental U-curve.

Bangladesh is a poor developing country where the main means of subsistence is still drawn from agriculture, although its percentage share in GDP continues to fall over time. Bangladesh is only 1/5th the size of the state of Texas in the USA, but yet with over 150 million inhabitants it is almost half the population of the USA. This creates necessitates an increased emphasis on industrialization for domestic consumption and exports to earn hard foreign currencies. Bangladesh also endeavors to attract FDI for job creation. At an early stage of industrialization, the above factors are likely to contribute to significant emissions of CO_2. Additionally, the level of environmental awareness is still relatively low in Bangladesh.

The primary objective of this study is to investigate the role of industrial production, FDI and rising population by determining the level of CO_2 emissions in Bangladesh, using the Autoregressive Distributed Lag (ARDL) model for co-integration and long-run causality with short-run interactive feedback effects. The paper is structured as followed: Section 2 briefly reviews the related literature. Section 3 outlines the ARDL empirical methodology. Section 4 details results and Section 5 offers conclusions and remarks.

2. Brief Review of Related Literature

Grossman and Krueger (1991) found that the long-term relationship between economic growth and environment quality was an inverted U-shaped curve. The phenomenon has been labeled as the Environmental Kuznets Curve (EKC) by Panayotou (1993). The EKC hypothesizes that environment quality deteriorates with the increase of per capita income at the early stage of economic growth and gradually improves when the country reaches a certain level of affluence. Since then, extensive empirical studies have been conducted to test the EKC hypothesis. The effect of economic growth on environmental quality is the basis for many disputes.

Most of the empirical studies are based on multi-countries. In fact, the EKC hypothesis is fundamentally taking place on a national level. However, cross-country analysis assumes that all cross-section countries react identically, no matter how different they are in terms of income, geographical conditions, culture and history (Dijkgraaf and Vollegergn, 1998). In recent years, some researchers have begun to use individual countries to test the EKC hypothesis (i.e. Unruh and Moomaw, 1998; De Brueyn, 2000; Lekakis, 2000; Stern and Common, 2001; Cole, 2003). Besides the income factor, environmental quality is also affected by other factors, such as economic structure, international trade, FDI, environmental regulation and so on; although most of the empirical studies merely focused on the income level. A growing world needs more input to expand outputs, which implies that waste and emissions as by-products of economic activities will increase (Grossman and Krueger, 1995). With economic growth, the production structure will change, from clean agrarian economies to polluting industrial economies and further to clean service economies (Arrow et. al., 1995). As Panayotou (1993) points out, when the sectors of an economy shift mainly from agriculture to industry, pollution intensity increases. This is because more and more resources are exploited and the exhaustion rate of resources begins to exceed the regeneration speed of resources. When the industrial structure enhances further, from energy intensive heavy industry to service and technology-intensive industries, pollution decreases as income grows. The upgrading of industrial structure needs the upgrading of technology. Technical progress makes it possible to replace the heavily polluting technologies with cleaner ones. It is the trade-off between scale effect and technology effect that causes that the environment to deteriorate at the first industrial structural change and improves at the second industrial structural change, making the relationship between environment and economic growth look like an inverted-U curve. The downward sloping portion of the environment and economic growth may be facilitated by advanced economies exporting their pollution-intensive production processes to less-developed countries (Suri and Chapman, 1998).

In another vein, international trade and FDI help explain the EKC hypothesis. International trade and FDI have contradictory impacts on the environment. International trade especially exports and inflows of FDI lead to increased use of land and natural resources, as well as encouraging consumption, which will cause more pollution due to more production and/or consumption, while international trade and FDI also have positive effects on the environment by the composition effect and/or technology effect, which are attributed to Displacement Hypothesis and Pollution Haven Hypothesis (Dinda, 2004). To developing countries, FDI might bring improved efficiency and cleaner technology, which offers opportunities to improve the most damaging phases of industrialization (Goldemberg, 1998). Pollution emissions may drop due to trade openness, since the economies gain more environmental awareness under greater competitive pressure. But trade and FDI might facilitate advanced economies to export their pollution-intensive production processes to less-developed countries due to different environmental stringent policies (Suri and Chapman, 1998). This will speed up the pollution level of less-developed countries. As Arrow et al. (1995) and Stern et al. (1996) pointed out, if there was an EKC type relationship, it might be partly or largely a result of the effects of trade on the distribution of polluting industries.

3. Empirical Methodology

To begin with, the nature of the data distribution of each variable is examined by descriptive statistics. To examine the time series property of each variable, the Augmented Dickey–Fuller test (Dickey and Fuller, 1981; Fuller, 1996) and the KPSS (Kwiatkowski et al., 1992) test have been applied, although such pre-testing is optional in the Autoregressive Distributed Lag (ARDL) model.

In the event of non-stationary of variables, the most commonly used procedures for ascertaining the co-integrating relationship include Engle and Granger (1987) residual-based procedure and Johansen and Juselius (1992, 1999) maximum likelihood-based procedure. Both procedures concentrate on cases in which the underlying variables are integrated of order one, which is highly unlikely in the real world. To address the issue of unequal order of integration of non-stationary variables for a long-term equilibrium relationship and causal flows, the ARDL model or the bound testing procedure suggested by Pesaran et al. (2001) has been used in this study. It is applicable irrespective of whether the regressors in the model are purely I (0) and I (1) or mutually integrated. Another advantage of this approach is that the model uses a sufficient number of lags to capture the Data Generating Process (DGP) in a General to Specific (GETS) modelling framework. A dynamic Error Correction Model (ECM) can also be derived from the ARDL procedure through a simple linear transformation. The ECM integrates the short-run dynamics with the long-run equilibrium relationship without losing long-term memory.

The ARDL procedure based on a bound testing approach uses the following unrestricted model as found in the work of Pesaran and Shin (1999) and Pesaran et al. (2001). Assuming a unique long-run relationship among the weakly exogenous independent variables, the following estimating Vector Error-Correction Model (VECM) is specified:

$$\Delta \ln Car_t = \alpha_0 + \sum_{i=1}^{p} b_i(\Delta \ln Car_{t-i}) + \sum_{i=0}^{p} c_i(\Delta \ln Ind_{t-i}) + \sum_{i=0}^{p}$$

Where, Car = carbon dioxide (CO_2) emission, Ind = industrial output, Fdi = foreign direct investment and Pop = population size. All first-differenced variables here are in natural logs. To implement the bound testing procedure, the following steps are outlined:

First, testing for weak exogeneity, the ARDL procedure is implemented through Vector Autoregressive (VAR) pair-wise Granger Causality/Block Exogeneity Wald Tests. Johansen (1988) stated that the weak exogeneity assumption influences the dynamic properties of the model and must be tested in the full system framework.

Second, equation (1) has been estimated by Ordinary Least Squares (OLS) in order to test for the existence of a co-integrating relationship among the variables through conducting F-test for the joint significance of the coefficients of the lagged variables in levels. The null and the accompanying alternative hypotheses for the co-integrating relationship are

Ho: $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$ for no co-integration
Ha: $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$ for co-integration

If the calculated F-statistic is above its upper critical value, the null hypothesis of no long-run relationship can be rejected irrespective of the orders of integration for the time series. Conversely, if the calculated F-statistic falls below its lower critical value, the null hypothesis cannot be rejected. If the calculated F-statistic falls between its lower and upper critical values, the inference remains inconclusive.

Third, on the evidence of co-integrating relationship, the following conditional ARDL (p_1, q_1, q_2 and q_3) model is estimated:

$$\Delta \ln Car_t = \alpha_0 + \sum_{i=1}^{p1} \alpha_{1 \ln Car_{t-i}} + \sum_{i=0}^{q1} \alpha_{2 \ln Ind_{t-i}} + \sum_{i=0}^{q2} \alpha_{3 fdi_{t-i}} + \sum_{i=0}^{q3} \alpha_4 \ln Pop_{t-i} + \omega_t \ldots\ldots\ldots\ldots\ldots(2)$$

The optimum lag orders in the above are selected by the Akaike Information Criterion (AIC) as found in the work of Akaike (1969). The optimum lags are selected appropriately to reduce residual serial correlation and to avoid over-parameterization. According to the recommendation of Pesaran and Shin (1999) for annual data, a maximum of two lags was selected.

For subsequent use in the VECM, the error-correction term (ECM_{t-1}) is obtained from the following equation:

$$ECM_{t-1} = \ln Car_t - \widehat{\alpha_0} + \sum_{i=1}^{p^1} \widehat{\alpha_1} \ln Car_{t-i} + \sum_{i=0}^{q^1} \widehat{\alpha_2} \ln Ind_{t-i} \sum_{i=0}^{q^2} \widehat{\alpha_3} \ln fdi_{t-i} + \sum_{i=0}^{q^4} \widehat{\alpha_4} \ln Pop_{t-i} \cdots \cdots \cdots (3)$$

Finally, the short-run and long-run dynamics are captured by estimating the following VECM:

$$\Delta \ln Car_t = \beta_0 + \sum_{i=1}^{p} \beta_{1_{\Delta \ln Car_{t-i}}} + \sum_{i=0}^{p} \beta_{2_{\Delta \ln Ind_{t-i}}} + \sum_{i=0}^{p} \beta_{3_{\Delta \ln fdi_{t-i}}} + \psi ECM_{t-1} \dots\dots\dots (4)$$

Where, β are the coefficients relating to the short-run dynamic elasticises and Ψ is the speed of adjustment to the long-run equilibrium associated with the error-correction term, ECM_{t-1}. The expected sign of Ψ is negative. Its statistical significance is reflected through the associated t-value and its numerical magnitude indicates the speed of adjustment towards a long-run equilibrium.

Annual data from 1972 to 2008 are employed in this study. The number of sample observations is relatively small for a meaningful co-integration analysis. A bigger sample period can partially overcome this problem (Hakkio and Rush, 1991). In contrast, when a sample period is relatively small, high frequency data may partially compensate for this deficiency (Zhou, 2001). The CO_2 emission data were obtained from the Carbon Dioxide Information Analysis Center at the Oak Ridge National Laboratory (2009) and are in per capita terms and in metric tons, excluding emissions from land use and agriculture. Industrial production data, obtained from World Development Indicators (2009), were at a constant 2000 (US dollar). FDI data were nominal and in US dollar, obtained also from World Development Indicators (2009) of the World Bank. Population data were obtained from various sources of International Financial Statistics, IMF.

4. Results

The data descriptors are reported in Table 1:

A cursory inspection of Table 1 reveals that all descriptive statistics including Jarque–Bera corroborate normal distribution of each variable except for lnFDI. Weak exogeneity test results are reported in Table 2.

Considering population (lnPop) as exogenous to the system and treating LnIND and LnFDI as weakly exogenous, the parameter of the conditional scalar variable (LnCar) is meaningfully estimated independently of the marginal distribution of LnIND and LnFDI, as stated by Johansen (1988) and Pesaran et al. (2001). The Chi-square value from the underlying VAR model is 36.85419 with p-value

Table 1: Descriptive statistics

Descriptors	LnCAR	LnIND	lnFDI	LnPOP
Mean	–2.055147	22.0682	197.8619	4.696007
Median	–2.009915	21.99266	7	4.698296
Maximum	–1.241329	23.25308	1086.3	5.075174
Minimum	–2.995732	20.53408	–8.000000	4.282068
Std. Dev.	0.512581	0.668197	300.1324	0.238232
Skewness	–0.044043	–0.025962	1.361373	0.006122
Kurtosis	1.780291	2.225368	3.776772	1.844811
Jarque-Bera	2.305483	0.92924	12.3591	2.057524
Probability	0.31577	0.628374	0.002071	0.357449
Sum	–76.04045	816.5233	7320.889	173.7523
Sum Sq. Dev.	9.458613	16.07352	3242861	2.043155
Observations	37	37	37	37

0.0000. This indicates that all level variables are globally exogenous. The individual Chi-square values also support this finding.

Table 2: Weak Exogeneity Tests (VAR pair-wise Granger causality/block exogeneity Wald tests)

Dependent variable: LNCARBON			
Excluded	Chi-sq	Df	Prob.
LNIND	28.36388	3	0
LNFDI	34.33534	3	0
All	36.85419	6	0

The time series property of each variable is examined by both, the ADF test and its counterpart KPSS test. The results are reported in Table 3.

Table 3: Unit Root Tests (ADF and KPSS)

Variables	ADF		KPSS	
Level	1st Difference	Level	1st Difference	Level
lnCAR	–0.694050	–5.970553*	0.732201*	
lnIND	1.810694	–2.429028	0.745831	0.184255*
lnFDI	0.248215	–6.241580*	0.611091*	
lnPop	–1.075871	–6.127511*	0.729319*	

Notes: *The MacKinnon (1996) ADF critical values are –3.752946 and –2.998064 at 1% and 5% levels of significance, respectively. The KPSS (Kwiatkowski et al., 1992) critical values are 0.73900 and 0.46300 at the aforementioned levels of significance, respectively.Table 3 reveals non-stationary of each variable with different orders of integration. Subsequently, the estimates of equation (1) for co-integration are reported in Table 4.

Table 4: F-statistics for Co-integration Relationship

Dep. Var.	F-Statistics	Probability	Out come
FCAR (CAR|IND, FDI,POP)	4.640954	0.001	Co-integration
F IND (IND|CAR, FDI,POP)	3.72323	0.004	No co-integration
F FDI (FDI|CAR, IND,POP)	2.08841	0.067	No co-integration
F POP (POP|CAR, IND,POP)	1.26949	0.306	No co-integration

The asymptotic critical Value bounds are min F =2.86 & Max F =4.01 at 5 % level (Table C1 iii. unrestricted intercept and no trend, Pesaran et al. (2001)

Table 4 illustrates the results of the calculated F-statistics when each variable is considered as a dependent variable (normalized) in the ARDL-OLS regressions. The calculated F-statistics, F car (Car|Ind, FDI, POP) = 4.640954 is higher than the upper bound critical value of 4.01 at the 5% level. Moreover, none of the estimated coefficients of LnCar, LnInd, LnFdi and LnPop as represented by λ_1 , λ_2, λ_3 and λ_4 respectively is equal to 0. This is an affirmation of the presence of a long-run equilibrium relationship among the variables. Thus, the null hypothesis of no co-integration is rejected, implying a long-run co-integrating relationship among the variables when regressions are normalized on the CO_2 variable.

On the evidence of a co-integrating relationship, equation (2) was estimated using the following ARDL (2, 2, 1, 1) specification to unveil the long-run relationship. The results obtained by normalizing on per capita CO_2 emission in the long run are reported in Table 5.

Table 5: ARDL Long-run Estimation of LnCAR (2,2,1,1)

Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	–14.62797	0.949170	–15.41133	0.0000
lnIND	0.235969	0.093491	2.523979	0.0166
lnFDI	–8.79E-05	5.41E-05	–1.623435	0.1140
lnPOPU	1.572144	0.256271	6.134686	0.0000

The estimated coefficients show that, both industrial production as well as population, have statistically significant positive impacts on CO_2 emissions in Bangladesh. Growing industrialization implicates a serious threat to the environment. Toxic waste from industries and factories, mostly established on the banks of the rivers, contaminates the water of the rivers as waste is not being treated by Affluent Treatment Plants (ATP), although it is mandatory for factories that dispose of toxic waste. Population growth contributes to the degradation of the environment through contaminating drinkable water and clogging the sanitation pipes. Also, numerous vehicles and traffic congestions in the capital city, increasing uses of refrigerators and air coolers are prone to CO_2 emissions. Furthermore, lnFDI has negative effects on CO_2 emissions, although it is statistically insignificant. It means inflow of FDI in Bangladesh contributes marginally in reducing CO_2 emissions. This is a result of foreign-owned enterprises' compliances with the environmental standards set by the Department of Environment (DoE).

The estimates of VECM are specified in equation (4), and are reported in Table 6.

Table 6: ARDL (2,2,1,1) vector error-correction model of LnCAR

Variables	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.036778	0.043873	0.838287	0.4105
ECM $_{t-1}$	−0.750210	0.238452	−3.146169	0.0045
Δ (LnCAR (-1))	0.212594	0.206878	1.027629	0.3148
Δ (LnCAR(-2))	0.025375	0.192480	0.131834	0.8963
Δ (LnIND)	0.265894	0.286973	0.926548	0.3638
Δ (LnIND(-1))	−0.043218	0.146802	−0.294395	0.7711
Δ (LnIND(-2))	0.102055	0.108315	0.942202	0.3559
Δ (FDI)	1.84E-06	6.19E-05	0.029674	0.9766
Δ (FDI(-1))	8.59E-05	7.66E-05	1.120598	0.2740
Δ (LNPOP)	1.098021	0.875253	1.254519	0.2223
Δ (LNPOP(-1))	−2.270883	0.752532	−3.017656	0.0061
R-squared	0.529096	Mean dependent var.		0.045752
Adjusted R-squared	0.324356	S.D. dependent var.		0.053969
S.E. of regression	0.044361	Akaike info criterion		−3.136711
Sum squared resid.	0.045262	Schwarz criterion		−2.642888
Log likelihood	64.32408	Hannan–Quinn criter.		−2.968303
F-statistic	2.584227	Durbin–Watson stat		2.089146
Prob. (F-statistic)	0.028935			

The estimated coefficient λ of the error-correction term (ECM_{t-1}) at –0.750210 is highly significant in terms of the associated t-value with the expected negative sign and its numerical magnitude indicates significant speed of adjustment towards long-run convergence. In the short–term, interactive feedback effects are positive, but statistically insignificant in terms of the insignificant associated individual t-value. The DW-value at 2.089146 indicates near absence of autocorrelation. The numerical value of shows that only 32% of the change of CO_2 emissions in Bangladesh is explained by the changes in industrial production, foreign direct investment and population. The F-statistic at 2.584227 suggests moderate interactive feedback effects within the system.

Furthermore, Figures 1 and 2 show that both the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) plots from a recursive statement of the model lie within the 5% critical bound. Thus, parameters of the VECM do not suffer from any structural instability, i.e. there is strong evidence in favor of stable parameters.

Figure 1: CUSUM of Recursive Residuals

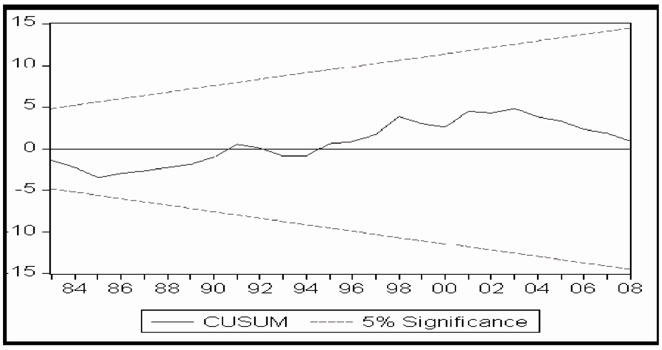
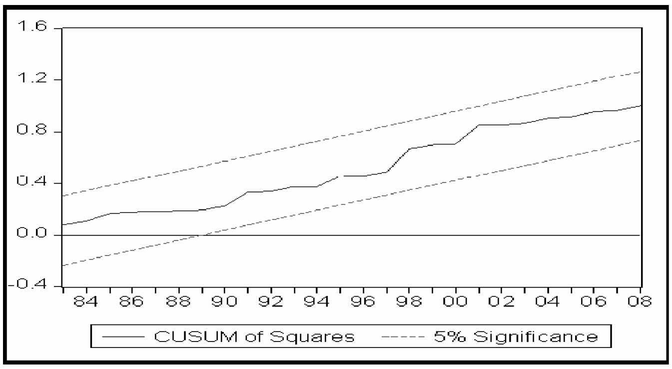


Figure 2: CUSUMSQ of Recursive Residuals



5. Conclusions and Remarks

All the variables examined in the study are non-stationary in log-levels with different orders of integration. The estimates of the ARDL model lend support to the existence of a co-integrating relationship among the variables. The estimates of the VECM depict a strongly positive long-run causal flow from industrialization and population growth to CO_2 emissions in Bangladesh while that from growth in FDI is negative and relatively subdued. There are evidences of short-run net positive interactive feedback effects among the variables.

For policy implications, Bangladesh should be poised for larger emissions of CO_2 in an early phase of industrial expansion and in the face of rapid population growth in large cities. FDI inflow should be encouraged to mitigate the problem. Once achieving a certain prescribed threshold level of per capita real GDP, the country should devote attention to improve environmental quality. At the same time, population growth should further be monitored in large cities by a wider geographic distribution of industries throughout the country. Bangladesh can draw lessons from China in these respects.

In conclusion, environmental awareness in Bangladesh is surging slowly. Although CO_2 emissions have drawn worldwide attention, other common pollutants such as sulphur dioxide (SO_2), carbon monoxide (CO), nitrogen oxide (NO_x), ground-level ozone (O_3), hydrogen sulphide (H_2S), etc., should also be mitigated in order to improve the overall environmental quality in Bangladesh.

References

1. Akaike, H. (1969) 'Fitting Auto Regression for Prediction', *Annals of the Institute of Mathematical Statistics*, Vol. 21, pp.243–247.
2. Arrow, K., Bolin, B., Costanza, R., Dasgupta, P., Folke, C., Holling, C.S., Jansson, B-O., Levin, S., Mäler, K-G., Perrings, C. and Pimentel, D. (1995) 'Economic Growth, Carrying Capacity, and the Environment', *Ecological Economics*, Vol. 15, No. 2, pp.91–95.
3. Cole, M.A. (2003) 'Development, Trade, and the Environment: How Robust is the Environmental Kuznets Curve?' *Environment and Development Economics*, Vol. 8, pp.557–580.
4. De Brueyn, S.M. (2000) '*Economic Growth and the Environment'*, Kluwer Academic Publishers, The Netherlands.
5. Dickey, D.A. and Fuller, W.A. (1981) 'Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root', *Econometrica*, Vol. 49, pp.1057–1072.

6. Dijkgraaf, E. and Vollegergn, H.R.J. (1998) 'Environmental Kuznets Revisited: Time Series versus Panel Estimation: the CO2 Case', Erasmus University Rotterdam, *OC/EB, and Research Memorandum 9806*.

7. Dinda, S. (2004) 'Environmental Kuznets Curve Hypothesis: A Survey', *Ecological Economics*, Vol., 49, No. 4, pp. 431–455.

8. Engle, R. and Granger, C.W.J. (1987) "Co-integration and Error-correction: Representation, Estimation, and Testing", *Econometrica,* Vol. 35, pp.315–329.

9. Fuller, W.A. (1996) *Introduction to Statistical Time Series*, John Wiley and Sons, New York.

10. Goldemberg, J. (1998) 'Leapfrog Energy Technologies', *Energy Policy,* Vol. 26, No. 10, pp.729–741.

11. Grossman, G.M. and Krueger, A.B. (1991) Environmental Impacts of a North American Free Trade Agreement, *NBER Working Paper* No. 3914.

12. Grossman, G.M. and Krueger, A.B. (1995) 'Economic Growth and The Environment', *Quarterly Journal of Economics,* Vol. 110, No. 2, pp.353–377.

13. Hakkio, C.S. and Rush, M. (1991) 'Cointegration: How Short is The Long Run?' *Journal of International Money and Finance,* Vol. 10, pp.571–581.

14. Johansen, S. (1988) 'Statistical Analysis of Cointegration Vectors', *Journal of Economic Dynamics and Contro*l, Vol. 12, pp.231–254.

15. Johansen, S. and Juselius, K. (1992) 'Testing Structural Hypothesis in Multivariate Cointegration Analysis of the PPP and VIP for UK', *Journal of Econometrics,* Vol. 53, Nos. 1–3, pp.211–244.

16. Johansen, S. and Juselius, K. (1999) "Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money", *Oxford Bulletin of Statistics*, Vol. 52, No. 2, pp.169–210.

17. Kwiatkowski, D., Phillips, P.C.B., Schmidt, P. and Shin, Y. (1992) 'Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root', *Journal of Econometrics*, Vol. 54, pp.159–178.

18. Lekakis, J.N. (2000) 'Environment and Development in a Southern European Country: Which Environmental Kuznets Curves?' *Journal of Environmental Planning and Management*, Vol. 43, No. 1, pp.139–153.

19. Mackinnon, J.G. (1996) 'Numerical Distribution Functions for Unit Root and Cointegration Tests', *Journal of Applied Econometrics,* Vol. 11, pp.601–618.

20. Panayotou, T. (1993) Empirical Tests and Policy Analysis of Development, ILO

Technology and Employment Programme, *Working Paper,* WP238.

21. Pesaran, M.H. (1997) 'The Role of Economic Theory in Modeling The Long-Run', *Economic Journal*, Vol. 107, pp.178–191.
22. Pesaran, M.H. and Shin, Y. (1999) 'An Autoregressive Distributed Lag Modeling Approach to Cointegration Analysis', In Sorm, S. (Ed.): Econometrics and Economic Theory in the 20th Century: *The Ragnar Frisch Centennial Symposium*, Cambridge University Press, Cambridge.
23. Pesaran, M.H., Shin, Y. and Smith R.J. (2001) 'Bound Testing Approaches to the Analysis of Level Relationship', *Journal of Applied Econometrics,* Vol. 16, pp.289–326.
24. Stern, D.I. and Common, M.S. (2001) 'Is There an Environmental Kuznuts Curve and for Sulphur?' *Journal of Environmental Economics and Management*, Vol. 41, No. 2, pp.162–178.
25. Stern, D.I., Common, M.S. and Barbier, E.B. (1996) 'Economic Growth and Environmental Degradation: The Environmental Kuznets Curve and Sustainable Development', *World Development*, Vol. 24, No. 7, pp.1151–1160.
26. Suri, V. and Chapman, D. (1998) 'Economic Growth, Trade and the Energy: Implications for the Environmental Kuznets Curve', *Ecological Economics*, Vol. 25, No. 2, pp.195–208.
27. Unruh, G.C. and Moomaw, W.R. (1998) 'An Alternative Analysis of Apparent EKC-Type Transitions', *Ecological Economics,* Vol. 25, No. 2, pp.221–229.
28. Zhou, S. (2001) 'The Power of Cointegration Tests versus Data Frequency and Time Spans', *Southern Economic Journal*, Vol. 67, pp.906–921.

Footnoting and writing style of the Bangladesh Journal of Political Economy

1. The Bangladesh Journal of Political Economy will be published in June and December each year.
2. Manuscripts of research articles, research notes and reviews written in English or Bangla should be sent in triplicate to the Editor, The Bangladesh Journal of Political Economy, Bangladesh Economic Association, 4/c Eskaton Garden Road, Dhaka-1000, Bangladesh.
3. An article should have an abstract within 150 words.
4. Manuscript typed in double space on one side of each page (preferably with softcopy) should be submitted to the Editor.
5. All articles should be organized generally into the following sections: a) Introduction: stating the background and problem; b) Objectives and hypotheses; c) Methodological issues involved; d) Findings; e) Policy implications; f) Limitations, if any; and g) Conclusion (s).
6. The author should not mention his/her name and address on the manuscript. A separate page bearing his/her full name, mailing address and telephone number, if any, and mentioning the title of the paper should be sent to the Editor.
7. If the article is accepted for publication elsewhere, it must be communicated immediately. Otherwise, the onus for any problem that may are will lie on the author.
8. The title of the article should be short. Brief subheadings may be used at suitable points throughout the text. The Editorial Board reserves the right to alter the title of the article.
9. Tables, graphs and maps may be used in the article. Title and source(s) of such tables should be mentioned.
10. If the Editorial Board is of the opinion that an article provisionally accepted for publication needs to be shortened or particular expressions deleted or rephrased, such proposed changes will be sent to the author of the article for clearance prior to its publication. The author may be requested to recast any article in response to the review thereof by any reviewer.
11. The numbering of notes should be consecutive and placed at the end of the artile.
12. Reference in the text should be by author's last name and year of publication (e.g. Siddique, 1992, P. 9. In the list of references, the corresponding entry in the case of article should be in the following manner:

Siddique. H.G.A., "Export Potentials of Ready-Made Garments Industry-A Case Study of Bangladesh". The Dhaka University Studies. III, 1982, Pp. 66-67.

In the case of books, the following order should be observed: Author, title, place of publication, publisher, date of publication, page number. As for example: *Hye, Hasnat Abdul, Integrated Approach to Rural Development,* Dhaka: University Press Limited, 1984, Pp.3-4.

13. Reference mentioned in the text should be arranged in alphabetical order and provided at the end of the article.
14. The Bangladesh Economic Association shall not be responsible for the views expressed in the article, notes, etc. The responsiblity of statements, whether of fact or opinion, shall lie entirely with the author. The author shall also be fully responsible for the accuracy of the data used in his/her manuscript.
15. Articles, not accepted for publication, are not returned to the authors.
16. Each author will receive two complimentary copies of The Bangladesh Journal of political Economy and 25 off-prints.

Md. Abdul Wadud
A Note on the Impact of Microcredit on Farm Income in Bangladesh : A Propensity Score Matching Approach

Md. Saidur Rahman, Nahid Sattar
Adoption Performance of IRRI Supported Submergence Tolerant Rice Variety in Bangladesh

Sakib Hassan, Mahbub Hossain, Tofazzal Hossain Miah
Small-scale Commercial Vegetables Farming and its Implications for Improving Livelihoods of Char People

Jannatul Nasrin, Md. Taj Uddin
Financial Profitability of Aromatic Rice Production and its Impacts on Farmers' Livelihood in selected areas of Tangail District

Md. Ruhul Amin, Tofazzal Hossain Miah
Commercial Bean Farming under Different Farm Categories and its Impacts on Livelihoods of Farmers in Ishwardi Upazila of Pabna District

Md. Rais Uddin Mian, A.M. Kudrat-E-Huda
Profitability and Resource Use Efficiency of Maize Production in Changing Farming System and Its Implication in Household Food Security

Md. Rais Uddin Mian
Risk and Agricultural Production- An Assessment Towards Food Security in Kurigram District of Bangladesh

Mahnaz Afsar, Mahbub Hossain, Tofazzal Hossain Miah
Rice-sunflower Cropping Pattern and its Contribution to Income and Food Security of Polder Farmers

Bikash Chandra Ghosh, Md. Elias Hossain
Abnormal Population Growth and Its Effects on Agricultural Resource Management: Focusing the Global Situation with a Micro-level Example

A.N.K.Noman, Kazi Julfikar Ali
Climatic Variability, Agricultural Transformation and Food Security in the North-Western Bangladesh

Md. Atiqul Islam, A.N.K. Noman
Drought and Public Policy Concerns for North-Western Region of Bangladesh

Md. Selim Reza, Md. Moazzem Hossain Khan
Impact of Farm Mechanization on Productivity and Profitability of Rice Farm in Rajshahi District

Md. Sariful Islam, Kazi Julfikar Ali, M. Moazzem Hossain Khan
Impact of Education on Rice Production in the Northern Districts of Bangladesh: A Ridge Regression Analysis

বাংলাদেশ অর্থনীতি সমিতি

Bangladesh Economic Association
4/C, Eskaton Garden Road
Dhaka-1000, Bangladesh
Tel : 934 5996, Fax : 880-2-934 5996
Website : bea-bd.org
E-mail : bea.dhaka@gmail.com