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CROP-RESEARCH GENERATED TECHNOLOGY AND ITS IMPACT ON CROP-SECTOR IN BANGLADESH

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Abstract

This study has been taken to analyze the performance of Gross Domestic Product (GDP) by crop-sector due to utilize modern technology in Bangladesh. The growth of both GDP and crop-research investment is estimated mainly based on secondary data. The result of Chow Test under Structural Change Approach indicates there is a positive impact of crop-research generated technology on GDP by crop-sector in Bangladesh. The annual growth of Tk. 13.11 million of crop-research investment at Bangladesh Agricultural Research Institute (BARI) is able to increase the crop production. Consequently GDP increased by Tk. 13,441 million per year by which saved annually Tk. 7,749 million of crop import costing. Therefore, extra more amount of crop-research investment is needed for further development in Bangladesh crop-sector.

Key words: Crop-research investment, Crop-technology, GDP by Crop-sector.

Introduction

In Bangladesh rising population creates more demand for crop production. Practically the production of crop increases due to increase not only the area of land but also for different factors such as input availability and efficient use, farmers' socio-economic profile, weather, farm level investment, etc. In this situation, crop production can be increased using generated technology through higher research investment. Though food production, productivity, cropping intensity has increased due to modern technology needs more invest in crop-research and extension to face the growing food demand for the rising number of people. So, government has given emphasis on research investment to produce more crops production through generated crop-technology and also from their efficient use. The government is therefore, urged to raise the investment at least 2% of GDP as recommended by World Bank and FAO (FAO 1996; Strat. plan 1995). Investment in agricultural research in Bangladesh stands at only 0.20 of GDP even though agriculture contributes to 19.10% of GDP (Karim 1997). Different studies indicate that investment in agricultural research is highly rewarding and beneficial (Miah 2005; Nagy *et al*., 2000). Mondal (2010) mentioned the insufficiency investment in research.

A recent FAO commissioned study revealed that agricultural land availability declined at 0.18% annually during the period 1976-2000 and the declining trend accelerated sharply after 2000, recording a decline of 0.45 % annually during the period 2000-2010. This indicates that a sharp change is taking place in the trend of shifting land from crop agriculture towards settlement, infrastructure and commercial development (The Daily Star 2015). On the other hand, the first four years of Sixth Five Year Plan (6th FYP) showed the performance the agriculture sector. The downward trend in performance is largely due to weakness in the crop sub-sector. Non-crop agriculture fared better, especially in terms of a solid performance in fishing. Livestock did better than crops but could not sustain the momentum it gained during FY5-FY10. During the 1980's, crops and horticulture contributed 20% of GDP, which has gradually came down to less than 15% in the first decade of this millennium and recent estimates (FY13) show that its contribution to GDP is only 10.5%. Bangladesh needs to put much more than the 0.07% of agricultural GDP it spends on research and extension compared to 0.06% for all developing countries (7th FYP 2015). Actually a huge amount of investment is needed for generating 'appropriate, effective and economic' technology to produce required amount of crops from decreasing land. All researches cannot generate technologies and even all generated technologies are not adopted by the farmers to increase productivity and production of crops as well as GDP. The increased investment encourages scientists to develop technology to cope with the hazards of climate change and disseminate the same at farmers' level. To support their investments in agricultural research and extension, the impact analyses of modern crop-technology required by governments and donor agencies. Impact studies give information to researchers for research program and technology design. Nagi and Alam (2000) made a study on the impact of agricultural research in Bangladesh. They included six commodities named T. Aman rice,

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Boro/Aus rice, Wheat, potatoes, Jute and Sugarcane. Yasmin (2011) assessed the economic and social impact of research investment. Generated 17 technologies of BARI were compiled which determined returns to investment using Economic Surplus Model. A great positive impact of these generated technologies was found on area, production, employment and income generation, gain of knowledge (training and leaflets received, field day and demonstration) etc. Impact study of fisheries technology on its GDP under structural change approach has done (Yasmin and Alam 2015) but no study of this type has done for crop-sector. Crop-research generated technology influences GDP by crop-sector needs to analyze. With this view in mind, this research has been taken to estimate GDP before and after using crop-technology of Bangladesh in the context of research investment.

Materials & Methods

Model specification for Structural Change Approach

Theoretical Framework

The investment for crop-research is very important in generating crop-technology. Before research there was no technology in Bangladesh. Yield capacity was lower before research whereas after research, achieved higher production using high yielding variety and modern technology. In fact, investment for crop-research, research generated crop-technology, higher crop production and GDP by crop-sector; all are interrelated discussed as follows in Figure 1.

i) Research investment for generating crop-technology:

Figure 1 shows crop-research investment is a part of total investment at BARI which is very important in determining country's GDP. Total investment includes all types of expenditure like salary and allowances, overhead cost, research and other costs, and investment for research depends on the amount of total investment. Crop-research actually means the allocation of investment for research on crops. There are two sources of investment for crop-research like; revenue budget and development budget.

ii) Modern Technology of crops:

Crop-technology generates after research on crops. When technology generated from crop-research is named as crop-research generated technologies. A list and details of recent 96 transferable technologies of crops are already published in Technology Book (Hassan *et al*., 2014). To attain food-grain self-sufficiency, the government of Bangladesh has given special emphasis on increased crop production through expansion of generated crop-technology. However, a large use of crop technology has taken place due to dramatic increase in crop yield. Before introduction of technology, found lower crop production. As a result, GDP by crop-sector has been affected. GDP increases with the enhancing production of crops. Series of data on crop-research investment and GDP contained a structural break to the economy due to a change in technology developed. Therefore, crop technology has greater influence on the GDP by crop-sector in Bangladesh (Figure 1).

iii) GDP by crop-sector:

Investment for crop-research generates crop-technology and crop-technology enhances crop production implies increase of GDP. It depends on the utilization of crop-technology (Figure 1). To increase the GDP, must increase the production of crops which needs more amount of investment for crop-research. As all these are interrelated, the estimation of GDP performance needs to consider the status/situation of 'before and after' crop-technology generation. The research findings will be helpful for crop research organization to know their contribution in national GDP and bargaining for additional research fund/investment. On this background the growth of both crop-research investment and GDP by crop-sector is estimated. To find out the impact, "Chow Test" has been estimated under Structural Change Approach.

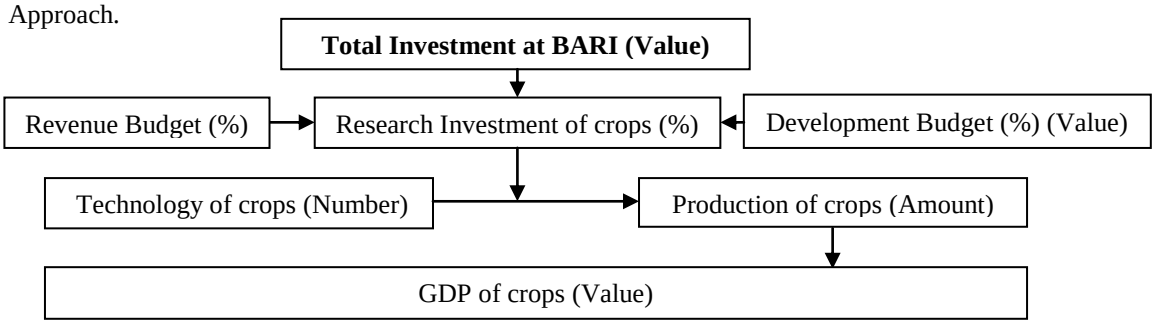

Figure 1: Flow Chart of "GDP by Crop- sector" in Bangladesh

Analytical Framework

"Chow Test" for Impact Analysis /Structural Stability:

A series of data can often contain a structural break, due to a change in policy or sudden shock to the economy, i.e. technology developed. In order to test for a structural break, often use the Chow test. The model in effect uses an F-test to determine whether a single regression is more efficient than two separate regressions involving splitting the data into two sub-samples. This could occur as Fig. 2, where in the second case has a structural break at t.

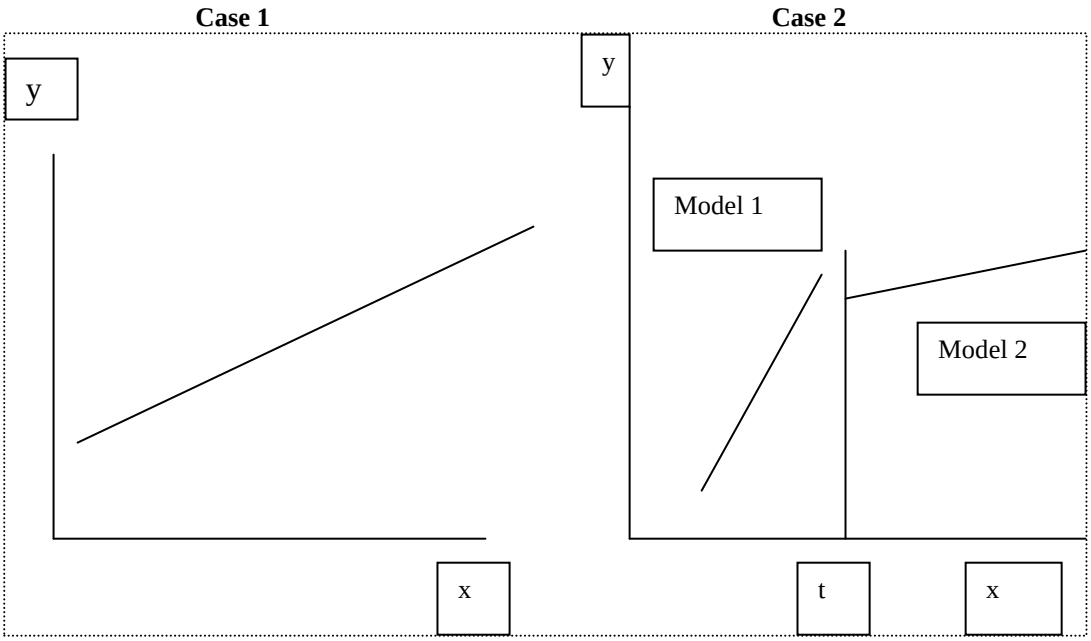

Figure 2: Structural Change

In the first case just have a single regression line to fit the data points (scatter plot), it can be expressed as:

$$y_t = \alpha_0 + \alpha_1 x_t + u_t$$

In the second case, where there is a structural break, we have two separate models, expressed as:

$$y_t = \beta_1 + \beta_2 x_t + u_{1t}$$
$$y_t = \delta_1 + \delta_2 x_t + u_{2t}$$

This suggests that model 1 applies before the break at time t, then model 2 applies after the structural break. If the parameters in the above models are the same, i.e. $\beta_1 = \delta_1, \beta_2 = \delta_2$, then models 1 and 2 can be expressed as a single model as in case 1, where there is a single regression line. The "Chow Test" basically tests whether the single regression line or the two separate regression lines fit the data best.

The stages in running the Chow test are:

1) Firstly run the regression using all the data, before and after the structural break, collect RSS_c.
2) Run two separate regressions on the data before and after the structural break, collecting the RSS in both cases, giving RSS_1 and RSS_2.
3) Using these three values, calculate the test statistic from the following formula:

$$F - \frac{RSS_c - (RSS_1 + RSS_2)/k}{RSS_1 + RSS_2 / n - 2k}$$

4) Find the critical values in the F-test tables, in this case it has F(k, n-2k) degrees of freedom.
5) Conclude the null hypothesis is that there is no structural break.

Chow test use to find out whether there is a structural change (Gregory 1960). The assumptions underlying the Chow test are twofold:
(a)u1t-$_{n(0,\ 2)}$ and u2t $N(0,\ 2)$ that is, the two error terms are normally distributed with the same (Homoscedastic) variance 2 and (b) u1t and u2t are independently distributed). The test can test whether there is structural stability of the regression model (Gujarati 1995).

Estimated Procedure

Statistical Analysis

Growth rates of Crop-research investment and GDP:

The following method is used for find out the growth rate.

Ye = a + bX.

Where, Ye = Dependent variable, a = Intercept, X = Independent variable, b = Growth rate

In this case b is the absolute growth rate, which indicates average change in GDP by crop- sector; research investment; research to total investment. Here the regression coefficient b indicates the magnitude of average change (both positive and negative) in GDP and research investment of BARI. Positive trend coefficients indicate that GDP, research investment and research investment to total investment are time dependent with upward trend. On the other hand negative trend coefficients indicate that GDP, research investment and research to total investment are time dependent with downward trend. Linear equation is fitted to the positive sign of the estimated trend coefficient (b) in all cases indicate a rising trend and negative sign indicate a downward trend.

Hypothesis Testing

There are four main categories of dependent variables in the study. The hypotheses are tested as follows:

GDP (crop-sector)

- The GDP is hypothesized as having no relationship with the time.
- There is no impact of research investment of crops on GDP by crop-sector.

Investment:

- The investment of crop-research is hypothesized as having no relationship with the time
- The investment of crop-research to total investment is hypothesized as having no relationship with the time.

Empirical Framework

Source of Data:

Investment data on crops from 1980-81 to 2009-2010 were collected only from BARI. GDP data by crop-sector from 1973-74 to 2009-2010 were collected from various issues of Statistical Year Book of Bangladesh.

E-views Software:

Original equation was estimated from 1973 to 2010, typing 1981 in the dialog specifies two sub-samples, one from typing-specifies two sub-samples, 1973 to 1980 and another one from 1981 to 2010.

Results and Discussion

Growth Analysis of GDP by Crop-sector and Crop-Research Investment for Generating Crop-Technology:

Table 1 and Table 2 show the growth of GDP by Crop-sector and Crop-Research Investment.

Results of "Chow Test" for Impact Analysis of Crop-Technology on GDP by crop-sector under Structural Change Approach (1973-2010)

GDP growth from 1973-2010:

Table 1 shows the growth of GDP increased significantly by Tk. 12,092 million per year. Results indicated modern technology has a great impact on GDP (Equation 1). Kamruzzaman et al. (1998) used a decomposition analysis to identify the factors influencing the output growth of pulses, oilseeds, potatoes from 1972-73 to 1992-93. Overall results indicated that most of the increase in output growth came from increased land area use.

GDP growth at Pre-modern technology period from 1973-1980:

Table 1 shows the growth of GDP increased significantly but only Tk. 5,691.8 million per year. During Pre-modern technology period (1973-1980), GDP increased in such small amount because of lower yield capacity. Though people of that period were interested to produce more but could not due to lack/absence of research investment as well as generated technology (Equation 2). In fact, during that period, GDP increased due to production increased only for using more land.

GDP growth at Post-modern technology period from 1981-2010:

Table 1 shows during Post-modern technology period (1981-2010) GDP increased significantly by Tk. 13,441 million per year because people of that period were able to produce more for using high yielding variety and modern technologies (Equation 3). GDP showed positive growth in terms of research investment. The growth rate of research investment was Tk.13.11 million per year which was 0.72% to total investment (Table 2). Yasmin and Alam (2015) mentioned at BFRI fisheries growth is only Tk.0.72 million per year which was 0.60% to total investment. It indicates investment for crop-research is in better condition compare to fisheries research. The higher percentage of research investment is found in case of crops. Due to lower yielding rate of local variety, farmers were interested to earn more profit using high yielding variety and modern technology. It may also be increased due to the awareness of nutrition and food security. On the other hand, land crisis was started with the rising demand of housing, urbanization, industrialization. Fulfillment of crop demand for rising people from small size of crop area indicated or implies a great contribution of modern technology.

Table 1 shows, GDP responded differently between the period 1973-80 and 1981-2010. Furthermore, the result of Chow Test ($F_{1,36}$ = 4.28) indicates, growth of GDP is not same at Pre and Post modern technology period, i. e. technology has great impact on GDP by crop-sector. It implies the growth of GDP increased with increasing investment of crop-research. Generated technology indicated the importance of research investment for crop production. By spending average Tk. 13.11 million per year for research investment can save crop import costing by Tk.7,749 million per year. Yasmin and Alam, 2015 mentioned rising research investment can save Tk. 8,653.30 million of fisheries import costing/expenditure. The performance of fisheries-sector is better than crop-sector may be due to proper use of fisheries-technology which is generated from fisheries-research. So, there is a scope to reduce import costing by proper using and generating more technology through enhancing investment in crop-research. As technology has great impact on GDP so there is an opportunity to produce more crops, reduce import costing and earn foreign exchange. Therefore, research investment is one of the important determinants for better performance of GDP by crop-sector.

Table 1: Co-efficient of Chow Test for GDP by crop-sector

Coefficients	**Period (1973-2010) Equation 1**	**Pre-Modern Technology Period (1973-1980) Equation 2**	**Post-Modern Technology Period (1981-2010) Equation 3**
Constant	-8,935.4	30,924	80,088
	(-2.03)*	(3.55)**	(0.47)
Average growth of	12,092	5,691.8	13,441
GDP per year	(1.96)*	(0.37)	(1.83)*
R^2	0.95	0.61	0.93
Chow Test	$F_{1,36}$= 4.28 Significant at 5% level		

The values in parentheses are t- values* significant at 5% level** significant at 1% level

Table 2: Growth of Total Research Investment (Tk. million) and Total Research Investment to Total Investment (%) per year for BARI, 1980-81 to 2009-10

Growth	**Estimated equations**	**Growth rate b Average Increase/year**	**R^2**
Total Research Investment	Y= 13.11x - 75.70	13.11 (3.28)**	0.75
Total Research investment to Total Investment	Y=0.72x+ 1411.57	0.72 (2.80)*	0.74

The values in parentheses are t- values. * Significant at 1% level and ** significant at 1% level

Investment Analysis for Crop-Technology Generation

In Table 3, total investment for crop was increased from Tk.74.00 million in 1980-81 to Tk. 1,549.83 million in 2009-10. The average total investment for crop was Tk. 543.46 million. Research investment for crop was increased from Tk. 7.04 million in 1980-81 to Tk. 428.30 million in 2009-10. It increased sharply. The average research investment for crop was Tk. 130.77 million. Research Investment to total investment was increased from 9.51% in 1980-81 to 27.64% in 2009-10. It was on average, 24.06 %. But in case of fisheries, Yasmin and Alam, 2015 mentioned fisheries research investment is only Tk. 8.74 million which was 11.59% of total investment at BFRI; lower than crop research. Actually, investment at BARI is not large amount compare to BFRI because there are different types of crops but only fish is considered at BFRI. Research investment of BARI (19.42 %) is in better condition compared to BFRI (11.59%).

Table 3: Investment, Million Tk., BARI, for Generating Crop-technology

Year	Total Investment	Total Research Investment	Research to Total Investment (%)
1980-81	74.00	7.04	9-51
1981-82	113.65	8.12	7.14
1982-83	128.48	9.11	7.71
1983-84	92.9	8.75	9.42
1984-85	105.37	9.6	9.11
1985-86	136.82	17.09	12.49
1986-87	178.57	31.79	17.80
1987-88	207.42	38.16	18.40
1988-89	177.83	19.94	11.21
1989-90	293.14	41.96	14.31
1990-91	279.07	62.03	22.23
1991-92	371.74	89.56	24.09
1992-93	405.12	93.18	23.00
1993-94	362.78	36.5	10.06
1994-95	568.07	95.98	17.05
1995-96	465.77	81.87	17.58
1996-97	545.58	91.29	16.73
1997-98	548.28	114.65	20.91
1998-99	577.62	111.37	19.28
1999-00	744.70	152.79	20.52
2000-01	577.88	147.85	25.58
2001-02	577.07	133.96	23.21
2002-03	492.02	152.28	30.95
2003-04	560.33	154.98	27.66
2004-05	520.86	160.91	30.89
2005-06	952.71	267.12	28.04
2006-07	1455.40	367.76	25.27
2007-08	1669.42	460.19	27.57
2008-09	1572.00	529.03	27.29
2009-10	1549.83	428.30	27.64
Average	**543.46**	**130.77**	**24.06**

Source: *Yasmin and Alam, 2011 (Authors' Calculation)*

Research Investment from Revenue Budget:

In Table 4, crop research investment from the source of revenue budget for BARI was increased from Tk. 1.4 million in 1980-81 to Tk. 111.95 million in 2009-10. It increased sharply. The average research investment (Revenue Budget) for BARI was Tk. 20.92 million. Research investment (Revenue Budget) to total research investment for BARI was increased from 19.89% in 1980-81 to 26.14% in 2009-10. It was on average only 10.12 % whereas in fisheries-sector it was about 65.24% of (Yasmin and Alam, 2015) It indicates among these sectors, investment needs to emphasis by Bangladesh Government in generating technology of crops through research in crop-sector.

Research Investment from Development Budget:

In Table 4, research investment (Development Budget) for BARI was increased from Tk. 5.64 million in 1980-81 to Tk. 316.35 million in 2009-10. It increased sharply. The average research investment (Development Budget) for BARI was Tk. 106.37 million. Research investment (Development Budget) to total research investment for BARI was increased from 80.11% in 1980-81 to 73.86% in 2009-10. It was on average about 89.91%. About 34.76% of fisheries (Yasmin and Alam, 2015) research investment coming from development budget indicates crop research (89.91%) is much higher than fisheries.

Table 4: Crop-Research Investment to Total Research Investment in (%) of BARI from 1980-81 to 2009-2010

Year	Revenue Budget (Tk. in million)		Development Budget (Tk. in million)	
	Research Investment from Revenue budget	Revenue Research Investment to Total Research Investment (%)	Research Investment from Development budget	Development Research Investment to Total Research Investment (%)
1980-81	1.4	19.89	5.64	80.11
1981-82	1.12	13.79	7.00	86.21
1982-83	1.12	11.30	8.79	88.70
1983-84	2.74	31.31	6.01	68.69
1984-85	1.79	18.65	7.81	81.35
1985-86	1.71	10.01	15.38	89.99
1986-87	1.79	5.63	30	94.37
1987-88	1.66	4.35	36.5	95.65
1988-89	1.68	8.43	18.26	91.57
1989-90	1.25	2.98	40.71	97.02
1990-91	0.70	1.13	61.33	98.87
1991-92	0.31	0.35	89.25	99.65
1992-93	0.08	0.09	93.1	99.91
1993-94	0.90	2.47	35.6	97.53
1994-95	0.77	0.80	95.21	99.20
1995-96	0.58	0.71	81.29	99.29
1996-97	0.76	0.83	90.53	99.17
1997-98	1.01	0.88	113.65	99.12
1998-99	1.71	1.54	109.66	98.46
1999-00	3.79	2.48	149.00	97.52
2000-01	3.41	2.31	144.44	97.69
2001-02	3.20	2.39	130.75	97.61
2002-03	3.20	2.10	149.07	97.90
2003-04	3.45	2.23	151.53	97.77
2004-05	6.75	4.19	154.16	95.81
2005-06	92.80	34.74	174.32	65.26
2006-07	107.30	29.18	260.46	70.82
2007-08	128.90	29.01	331.34	71.99
2008-09	144.65	33.72	284.38	66.28
2009-10	111.95	26.14	316.35	73.86
Average	**20.92**	**10.12**	**106.37**	**89.91**

Source: *Yasmin and Alam 2011(Authors' Calculation)*

Conclusion

About Tk. 13,441 million GDP per year increased due to increase research investment annually only 0.72% of total investment for producing a number of crop-technology. Only 10.09% research investment coming from revenue budget whereas 89.91% from development budget. Though research generating technology has positive significant effect on their production but it is clear that there is an opportunity/scope for extra more investment from government of Bangladesh mainly for crop-research. This study suggests for giving more attention for crop-research to increase the number of crop-technology. Therefore, if government gives emphasis on generation of effective crop-technology providing research investment it would have a great contribution to crop production implies GDP in future.

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