J. Sci. technol. (Dinajpur) Vol. 5: 98-110 (2007)
ISSN 1994-0386

EX-POST IMPACT OF RESEARCH AND EXTENSION FOR SHATABDI WHEAT VARIETY

M. Jahangir Kabir[1], M. E. Baksh[1,] M.G. Rabbani[2] and Rozina Yesmin Lucky[3]

ABSTRACT

An ex-post rate of return analysis was considered to estimate the internal rate of return (IRR) to WRC released improved variety Shatabdi that has been replaced the previous varieties. The growth rate of area, production and yield of wheat over the last 14 years were – 3.3 %, - 3.6 % and 0.57% respectively. After the release of improved variety of Shatabdi the area and production have been decreasing due to lack of seed of this variety and disease susceptibility of old variety Kanchan. The internal rate of return in Shatabdi research and extension was calculated at 59%. The average potential relative yield of Shatabdi variety over the Pre Shatabdi varieties was found 28 percent higher. Under various assumptions about the magnitude of the benefits and the research and extension expenditures, the IRR ranged between 46 percent and 73 percent. This indicates that the funding of Shatabdi research and extension is a good investment.

Key wards: *Wheat, Ex-post, Impact, Elasticity, Supply Shifter, IRR*

INTRODUCTION

Wheat was a minor crop before 1970's and increased its importance as second most important cereal in terms of both production and consumption after 1970's. The Bangladesh Agricultural Research Institute (BARI) with assistance from CIMMYT started research efforts on wheat in the early 1970's. Then most popular variety was Sonalika, which was released in 1973 by selection. By using CIMMYT assistance and germplasm, BARI released 1st variety Balaka in 1979. Wheat Research Center (WRC) under BARI was established in 1980 and released Kanchan in 1983, has become the most popular variety. Now a day Kanchan is suffering from BpLB diseases. Farmers are getting very low yield. A new promising variety Shatabdi has released in 2000. Kanchan is replacing by Shatabdi. Other varieties existence is minor in Bangladesh. Wheat varieties have either been introduced or have been improved through the research work of wheat research centre/CIMMYT Bangladesh. The analysis was also considered the benefits from wheat varietals development beginning in 2001/02, the first year when farmers adopted the Shatabdi.

The main objective of the research was to estimates the rate of return to Shatabdi variety that has been replacing the old varieties.

Specific objectives of the study are

1. To find the adoption situation of Shatabdi and yield advantages over pre Shatabdi varieties.
2. To estimate the rate of returns from Shatabdi variety research and extension.

[1]Senior Scientific Officer Department of Agricultural Economics, Wheat Research Centre, BARI, Nashipur, Dinajpur; [2]Lecturer, Department of Basic and Social Science, Dinajpur Government Veterinary Collage, Dinajpur; [3]Lecturer, Department of Economics, Hajee Mohammad Danesh Science and Technology University, Dinajpur

METHODOLOGY

The Ex-Post analysis with the help of Economic Surplus Model was considered for the present study to estimate the rate of returns of the improved variety Shatabdi that have been replacing the pre Shatabdi varieties. The period of the study was 1993/94 to 2006/07. There are two distinct parts of the analysis to obtain the rate of return to research and extension expenditures. The first is estimating the yearly stream of benefits in monetary terms that flow from an adopted intervention such as improved varieties. This was done by using the economic surplus model. Once the yearly benefits have been calculated, they are then related to the yearly cost of research and extension by calculating a benefit cost ratio or internal rate of return (IRR).

Economic Surplus Model

The concept of economic surplus has been used to measure economic welfare and the changes in economic welfare from policy and other interventions. (Alston *et al*., 1995; Currie, Murphy and Schmits, 1971). The economic surplus concept has been adapted to estimate the benefits from the adoption of improved variety. The components of economic surplus are consumer surplus and producer surplus. Given the initial condition (i.e., pre-research supply curve S_1 and demand curve D_1), consumer surplus is depicted as area P_aP_nBC in figure 1. This is the surplus or benefit to consumers because of a functioning market. That is, consumers are paying a lower price for thecommodity because of the quantity available through market activity. Consumer surplus is that area beneath the demand curve less the cost of consumption. The cost of consumption is the area below the price line P_n. Producer surplus is defined by area Area OBC - Area P_oP_nBA in figure 1. Area Area OBC - Area P_oP_nBA is the surplus left to the farmers after they have paid for the total costs of production. The adoption of an intervention by farmers such as an improved variety usually means one of two things: **i.** a farmer can supply more of the commodity using the same level of resources (i.e, same land area, other inputs), or **ii.** a farmer can supply the same level of commodity output but can do it with less resources. In either case, this is depicted by a shift to the right of the supply curve as shown in figure 1 (the shift is from S_1 to S_2). This shift is the supply curve from the adoption of an intervention changes the initial equilibrium price and quantity of the commodity. This new price quantity equilibrium increases economic surplus. The change in economic surplus (economic benefits) is measured by comparing the difference in economic surplus between the pre-adoption period and the post-adoption period.

Given a shift in the supply curve S_1 to S_2, the change in consumer surplus is depicted in figure 1 as area ABC + area P_oP_nBA. The shift in the supply curve (due to the adoption of an intervention) has decreased the price of consumers now have to pay for the commodity. Because of the decrease in the price of the commodity as a group will now purchase more of the commodity. The decrease in the price of the commodity has made the consumers in better situation. The change in consumer surplus (benefits) can be measured as a monetary value.

Given a shift in the supply curve S_1 to S_2, the change in producer surplus is depicted in figure 1 as area OAC - area P_oP_nBA. Area OAC in figure 1 represents the decrease in the cost of producing the same unit of the commodity that farmers now enjoy because they are using the intervention. This represents the benefits to the farmers from adopting the intervention and can be measured and quantified in monetary terms. The adoption of the intervention, however, has increased the quantity produced thereby decreasing the price of the commodity (P_n to P_o in Figure 1) and is a loss to farmers income. Farmers do make back some of this loss because now they sell more quantity (Q_n to Q_o in Figure 1) of the commodity. But in the final analysis, the lower price means that farmers have lost an amount equal to that depicted by area P_oP_nBA.

Farmers, as a group, gain from the adoption of an intervention if area OAC is larger than area P_oP_nBA. In some cases, area P_oP_nBA may be larger. The size of the two areas depends on the elasticity (%change in quantity relative to a %change in price) of the supply and demand curves and the size of the supply curve shift. The total social benefits to society from the adoption of an intervention is the summation of the change in consumer surplus plus the change in producer surplus (area ABC + area OAC) minus the input cost change from adoption of the new interventions. For some interventions, adopters may have to increase their input cost per hectare in order to obtain the advantage of the new variety (i.e. higher seed price) and these costs must be subtracted from the estimate of the total social benefits (Alston *et al*, 1995 chapter 5).

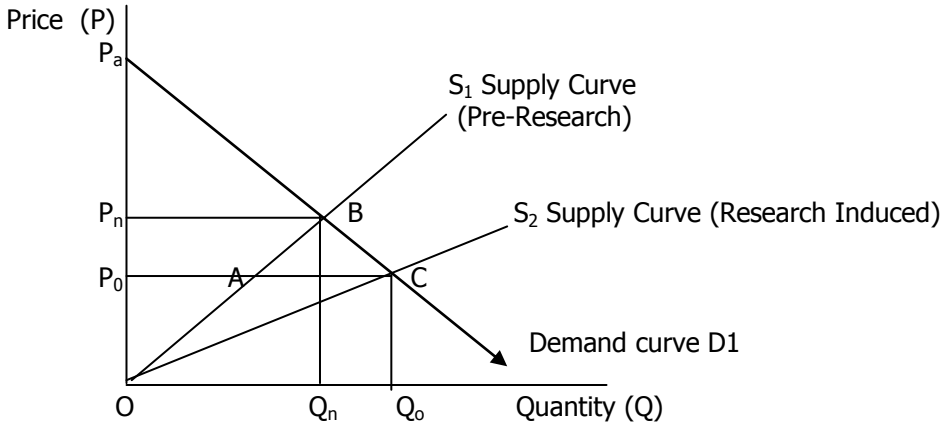

Figure 1. Small open-economy Economic Surplus Model

Distribution of Economic Benefits:
Change in Consumer Surplus = Area ABC + Area P_oP_nBA
Change in Production Surplus = Area OBC - Area P_oP_nBA
Change in total Economic Surplus = Area ABC + Area OAC

Akino and Hayami Method: Empirical Approach
The Akino and Hayami (1975) approximation formulas for calculation changes to producer and consumer economic surplus are used in this study. Although other methods are equally as good, the Akino and Hayami method is used in this study because it is a relatively straight forward method (Alston et al., 1995). The Akino and Hayami (1975) approximation formula for calculation of the change in economic surplus for a small open-economy analysis (Fig-1) is as follows:

Area ABC = $0.5P_oQ_o((k(1+\gamma))^2/(\gamma+\eta))$ (1)
Area OAC= kP_oQ_o (2)
Area $P_oP_nBA=(P_oQ_ok(1+\gamma))(\gamma+\eta))$ x$(1-((0.5\ k(1+\gamma)\ \eta\ )/(\ \gamma+\eta))-0.5k\ (1+\gamma)$ (3)
Where,
P_o= Commodity price (existing market price)
Q_o= Quantity of the commodity (existing production)
P_n= Commodity price that would exist in absence of research
Q_n= Quantity of the commodity predicated that would exist in absence of research
k= Horizontal supply shifter
γ= Price elasticity of commodity supply

η= Absolute price elasticity of the demand for the commodity.

Weighted average yield calculation

Weighted average yield was calculated by using the following formula:

Average of the three years experimental yield was multiplied by 0.75. It was assumed that farmers may achieve 75% of the experimental yield.

Yield advantage calculation

Yield advantage was calculated by using the following formula:

Yield advantage = $(1 - y/y_t)$ x100

Where y= Weighted yield average of old variety Kanchon, y_t= Weighted yield average of Shatabdi

The supply shifter k calculation

The supply shifter k i.e., the overall yield advantage of improved varieties over the old varieties weighted by the area sown to the new variety is called the supply shifter. In case of Akino and Hayami (1975) approximation formulas, k is the horizontal shift from the equilibrium price P_n given S_1 to the equilibrium price P_o given S_2, which corresponds, to a distance equal to Q_nQ_o in Figure-1 (Gardiner et al., 1986; Nagy, 1991; and Nagy and Furtan, 1978).

The supply shifter k is calculated as follows:

$$kt = \sum_{i=1}^{n} [1-Y_t/Y_{it})]*A_{it}$$

Where:

Yit= Yield of the improved variety in year t

Yt= Yield of a base (or average of old varieties) that has been grown in the past and that would still be grown if no new varities had been developed

Ait= the proportion of the total area sown to other new variety in year t

n= the number of improved varieties

Several varietals experiments were undertaken since the variety has been developed in various regions of the country but the variety adoption rates were not recorded systematically. So, the existing variety information as well as seed production information was collected.

Growth Rate Calculation

The J.G. Nagy (2001) formulas for discrete compound Growth Rate Calculation was used for calculation of growth rate of wheat area, production and yield. Growth rate was calculated by using the following formula:

$$r = (((A/P)^{1/t} - 1)) \times 100$$

r = Growth Rate %, P = Value of the variable at the beginning of the period

A = Value of the variable at the end of the period, t = number of periods including first and last

Rate of Return Calculation

The internal rate of return (IRR) is calculated relating the total social benefit (TSB) minus an input cost change, if any, in each year to the research expenditure (C) in each year and is the discount rate that results in a zero net present value of the benefits. The IRR is calculated as:

$$O=\left[\sum_{t=1}^{n}(TSB_t - C_t)(1\times IRR)^{-t}\right]$$

The IRR can be defined as the rate of interest that makes the accumulated present value of the flow of cost equal to the discounted present value of the flow of returns, at a given point in time (Peterson, 1971, p.148-149). For example, an IRR of 20 percent means that on the average, each Taka invested in agricultural research and extension returns 20 percent annually from the date of the investment. Another interpretation is that if the yearly research and extension expenditures had been borrowed at an interest rate of 20 percent, the social benefits from research and extension would equal the cost of borrowing the funds. Two types of data are mainly needed for the analysis: i. market related data, and ii. research related data. Market related data and information were collected from published sources from different libraries and Divisions of the Institute. Market related data required for this analysis included annual wheat prices and production, and wheat supply and demand elasticity's. Research related data were obtained from the scientists and different department from the Institute. Research related data included annual area of varietals adoption by farmers, yield advantage of improved varieties the input cost change, if any, and research and extension expenditures.

Elasticity's

There are two estimated area response elasticity 0.61 and 0.91 (BRRI, 2006). Dey and Norton used 0.5 output supply elasticity for their ex-ante analysis. The present analysis considers 0.61 and 0.91 for supply and demand elasticity respectively. The analysis first used the small open-economy model and therefore, uses nearly elastic demand elasticity.

RESULTS AND DISCUSSION

Area, Production and growth rates

Table 1 presents wheat production, area, yield and prices and table 1 shows the growth rates. The overall wheat production trend appears to be negative (- 3.3% annual average growth rate). However, the abnormally high production year of 1997 to 2000 was the positive growth rate (5.89). The overall area growth rate was negative (-3.6%). The over all annual growth rate of yield was positive (0.57). The over all mean yield was found 2.01 ton/ha (Appendix 1). The wheat harvest prices (Appendix 1) were used in the study and were converted to 1997-98 constant prices using the Middle Income Group CPI Index.

Yield Advantage

Table 2 presents experimental yield trial data of wheat. The experiments compare the Kanchan, varieties other than Kanchan and Shatabdi. The data in Table 2 is based on experimental trials at various locations in 2004-05 and 2006-07 under on-farm conditions and management. The average experimental yields of Shatabdi, varieties other than Kanchan and Kanchan were 3.86 ton/ha, 2.79 ton/ha and 2.73 ton/ha respectively. Weighted average yield of the average experimental yields of Shatabdi, varieties other than Kanchan and Kanchan were 2.89 ton/ha, 2.09 ton/ha and 2.05 ton/ha respectively. Thus the relative yield of Shatabdi variety over Kanchan was found 28%.

Table 1. Growth rate of wheat area, production and yield

Items	Production (thousand MT)	Area thousand ha	Yield
Year (1993-1996)			
Mean	1230	648	1.90
STDV	104	37	0.06
CV (%)	8.429	6	3.28
Growth rate (%)	3.8	2.39	0.67
Year (1997-2000)			
Mean	1751	807	2.17
STDV	203	74	0.08
CV (%)	12	9	3.79
Growth rate (%)	5.89	4.04	1.84
Year (2001-2004)			
Mean	1510	707	2.13
STDV	184	53	0.13
CV (%)	12	8	6.29
Growth rate (%)	-7.23	-4.64	-2.58
Year (2005-2007)			
Mean	831	470	1.79
STDV	431	249	2.19
CV (%)	52	53	11.2
Growth rate (%)	-6.69	-10.2	4.68
Overall (1993-2007)			
Mean	1364	670	2.01
STDV	368	133	0.19
CV (%)	27	20	9.66
Growth rate (%)	-3.3	-3.6	0.57

Table 2. Wheat variety yield trial data and yield advantage of Shatabdi wheat variety

Items	Shatabdi (Ton/ha)	Kanchan (Ton/ha)	Others (Ton/ha)
2004-05	4.00	2.80	3.03
2005-06	3.40	2.48	2.66
2006-07	4.17	3.08	2.51
Average yield	3.86	2.79	2.73
Weighted average yield	2.89	2.09	2.05
Yield advantage	28%	29%	2%

Source: WRC 2005 and 2006

Supply Shifter k

The supply shifter k identifies the amount of production that can be attributed to varietals improvement research each year (i.e., the shift in the supply curve). The shifter accounts for the yield advantage of the: (1) the Varieties other than Kanchan and (2) Kanchan and is weighted by the percentage area each is being replaced by the variety Shatabdi (Table 3).

Table 3: Supply Shifter k

% Area Shatabdi replacing Kanchan & Others	% Area Kanchan Sown	% Area sown to Others	Total Wheat Area (Thousand hectare)	Area Shatabdi replacing Kanchan & othres (Thousand hectare)	Area Kanchan Shown (Thousand hectare)	Area Sown to Others (Thousand hectare)	Supply Shifter k
0%	80%	20%	832	0.0	665.6	166.4	0.226
1%	80%	19%	773	7.7	618.4	146.9	0.228
5%	80%	15%	706	35.3	564.8	105.9	0.239
10%	75%	15%	706	70.6	529.5	105.9	0.240
10%	75%	15%	642	64.2	481.5	96.3	0.240
15%	70%	15%	558.4	83.8	390.9	83.8	0.241
20%	65%	15%	481	96.2	312.7	72.2	0.241
25%	60%	15%	371	92.8	222.6	55.7	0.242

doption Levels

Table 4 presents farmer adoption by variety category: (1) varieties other than Kanchan, and (2) kanchan and shatabdi. Kanchan still the most successful variety and occupied around 60% of the wheat areas in 2007. Three other promising varieties has released in 2005. No systematic surveys have been carried out for wheat variety. The adoption level has been calculated based on the perceptions of experienced field researchers.

Table 4. Adoption of wheat varieties developed by WRC, BARI, Bangladesh

Items	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
% Area of others varieties	20	20	20	20	15	15	18	20	19	15	15	15	15	15	15
% Area of Kanchan	80	80	80	80	85	85	82	80	80	80	75	75	70	65	60
% Area of Kanchan & other	100	100	100	100	100	100	100	100	99	95	90	90	85	80	75
% Area of Shatabhi	0	0	0	0	0	0	0	0	1	5	10	10	15	20	25
% Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 4. Adoption of wheat varieties developed by WRC, BARI, Bangladesh

Items	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Area other than kanchan (ha)	112	112	118	140	106	121	159	167	147	106	106	96	84	72	56
Area Kanchan (ha)	448	448	474	561	602	684	724	666	618	565	530	482	391	313	223
Area Shatabdi (ha)	0	0	0	0	0	0	0	0	8	35	71	64	84	96	93
Total area Wheat (ha)	560	560	592	701	708	805	883	833	773	706	706	642	558	481	371

Research and Extension Expenditures

Table 5 presents research and extension expenditures used in the analysis. Total expenditures include WRC expenditures, the WRC share of BARC administrative costs, and Department of Agricultural Extension expenditures. Research expenditures for the analysis started in 1993-94 and extension expenditures started in 2000-2001.

Only seven percent of BARI expenditures are included as costs in the analysis because the remaining 93% are other section research costs. BARC administrative expenditures for WRC research is set at 5% of total BARC expenditures. The 5% represents WRC total expenditures as a percentage of total spending by all research institutes/center within the BARC system. Extension costs incurred by DAE are based on the expenditure of demonstration, printing and delivery of leaflet for all crops. On average, 1% of the extension cost of DAE has been taken for wheat adoption. Thus 1% of total yearly expenditure of DAE is assigned to wheat extension. For the analysis, the expenditures are transformed into 1997-98 constant prices using the Middle Income Group CPI.

The analysis was undertaken over the years 1993-04 to 2006-07. However, research and development lags of seven years were employed in this study. Research expenditures started in 1993-94, extension expenditures started in 2001-02, and benefits started arriving in 2001-02. Research is assumed to stop in 2000 but it is anticipated that benefits from Shatabdi variety will still occur until the year 2014-15. The benefits for the years 2001-02 to 2002-03 are set equal to the average of the benefits that occur in 2000-01 to 2001-02. Thereafter, they depreciate by 5% per year. A maintenance research plus extension expenditure of one-third of the 2001-02 research and extension expenditure figure is applied to each year from 2001-02 to 2007-08 (Table 5).

Table 5. Wheat Research and Extension Expenditures

Years	BARC Administrative Expenditures (current Taka)	CIMMYT Expenditures (current Taka)	Extension Expenditures (current Taka)	Total Expenditures (current Taka)	Total Expenditures Based on (1997-98) Tk.	CPI Middle Income Group 1995-96=100 Dhaka
1993-94	3993250	11,970,000		101,503,250	60,293,484	168.35
1994-95	1127500	11,970,000		103,223,480	60,248,243	171.33
1995-96	857000	11,970,000		99,874,590	55,401,172	180.28
1996-97	1306250	14,700,000		109,676,400	58,458,326	187.61
1997-98	3379250	18326000.00		125,165,530	64,202,554,	194.95
1998-99	5908750	18326000.00		133,375,320	64,202,554	207.34
1999-00	6077500	18326000.00		153,218,550	69,732,033	219.72
2000-01	6246250	18326000.00	143087752	298,107,452	128,433,645	232.11
2001-02	6415000	19976000.00	150134958	308,605,808	126,221,512	244.50

Table 5. Wheat Research and Extension Expenditures

Years	BARC Administrative Expenditures (current Taka)	CIMMYT Expenditures (current Taka)	Extension Expenditures (current Taka)	Total Expenditures (current Taka)	Total Expenditures Based on (1997-98) Tk.	CPI Middle Income Group 1995-96=100 Dhaka
2002-03	6583750	21626000.00	157182164	319,104,164	124,222,692	256.88
2003-04	6752500	23276000.00	164229370	329,602,520	128,309,412	256.88
2004-05	6921250	24926000.00	171276576	340,100,876	132,396,412	256.88
2005-06	7090000	26576000.00	178323782	350,599,232	136,483,272	256.88
2006-07	7258750	28226000.00	185370988	361,097,588	140,570,132	256.88
2007-08	7427500	29876000.00	192418194	371,595,944	144,656,992	256.88

Source: Scientist Perception

The Rate of Return

Table 6 presents the Wheat research and extension rate of returns. Using the base parameters, the Wheat research and extension IRR is estimated to be 59%. Thus, on average, each Taka invested in research returns 59 paisa per year from the time it was invested until 2014-15. The B/C ratio was estimated to be 8.31:1. Thus, returns for per taka investment on research and extension is Tk 8.31, during 2000-01 to 2014-15. The net benefit earnings from the increased production of Shatabdi variety was Tk. 3377 million (considering constant prices in 1997-98).

Sensitivity analysis

A sensitivity analysis was undertaken for the study. When the yearly supply shifter k was decreased by 25%, there was a decrease in the rate of return to 51% (Table 7). When the supply shifter k was increased by 25%, the IRR increased to 67 % and the net benefit earnings also increased. When expenditures were increased by 25%, the IRR decreased to 46 %. An increase of 25% in the supply shifter k in combination with a decrease in the yearly expenditure by 25% increased the IRR 73% (Table 7).

Table 6. Rate of return of Shatabdi wheat variety through Ex-post analysis

Year	SE	DE	% Yield Change k	Commodity Price (Tk./ton) (1997-98 prices) Po	Quantity (Thousand ton) Qo	Change in CS (TK. million)	Change in PS (TK. million)	Change in TS (TK. million)	Research Costs (TK. million) C	Net Benefit (TK. million) NB
1993	0.61	0.91		3,081	1,176				60	-60
1994	0.61	0.91		4,345	1,131				60	-60
1995	0.61	0.91		4,140	1,245				60	-60
1996	0.61	0.91		3,896	1,369				55	-55
1997	0.61	0.91		4,124	1,454				58	-58
1998	0.61	0.91		3,955	1,803				64	-64
1999	0.61	0.91		4,032	1,908				64	-64
2000	0.61	0.91	0.226	3,684	1,840	1444	380	1824	70	1754
2001	0.61	0.91	0.228	3,560	1,673	1282	343	1625	128	1497
2002	0.61	0.91	0.239	3,504	1,606	1262	359	1621	126	1495
2003	0.61	0.91	0.240	3,435	1,506	1163	333	1495	124	1371
2004	0.61	0.91	0.240	3,373	1,253	950	272	1222	128	1093
2005	0.61	0.91	0.241	4,251	975	934	268	1202	132	1069
2006	0.61	0.91	0.241	4,732	772	825	238	1063	136	926
2007	0.61	0.91	0.242	5,803	746	980	283	1263	141	1123
Net Present Value (TK.million) (NPV**)**						3377				
Internal Rate of Return (IRR)						59%				
Benefit cost ratio						8.31:1				

Note: CS = Consumer's surplus, PS = Producer's Surplus, TS = Total Surplus, SE = Supply elasticity,
DE = Demand elasticity

Table 7. Sensitivity Analysis on the return to Jute O-9897 Variety Research and Extension

Scenarios	Scenarios
1. Base Parameters:	Return to Wheat Research & Extension
IRR	59%
B/C	8.31:1
Net Present Value(Taka Million)	3377
2. Supply Shifter k decreased by 25%	
IRR	51%
B/C	5.6:1
Net Present Value(Taka Million)	2259
3. Supply Shifter k increased by 25%	
IRR	67%
B/C	11.5:1
Net Present Value(Taka Million)	4914
4. Expenditures increased by 25%	
IRR	46%
B/C	4.38:1
Net Present Value(Taka Million)	2104

5. Supply Shifter k increased by 25% and Expenditures decreased by 25%	
IRR	73%
B/C	14:1
Net Present Value (Taka Million)	4754

CONSOLATIONS

The internal rate of return was found 59%. This IRR for investment in research and extension is a good rate of return. The IRR is estimated on the basis of some base parameters. Data of supply elasticity, percentage yield change, commodity price, quantity, and research cost are collected from different sources and data of input cost change per hectare, probability of success, exogenous output growth rate are assumed on the basis of some condition. The analysis also includes the benefits over the pre Shatabdi varieties was 28%. The benefit cost ratio was found 8.31:1 which indicated much higher benefits to the investment.

In the ex-post analysis, only the direct benefit from the increased yield was considered. Two other aspects have not been included which are: i, the benefits from maintenance research, and ii. the increase in commodity quality through research.
For this kind of analysis, the yield advantage was an important parameter for calculating the supply shift. So yield advantage information should have to be accurate. In this analysis, yield advantage has been calculated by the 3 years trial data, but breeder states that there is no fixed year for calculating yield advantage but at least it should be 7-8 years. So the average data needs to be more than 3 years on average experimental yield of competitive wheat variety.

The most important part of the analysis is the research cost. Every research institute expands its research costs for the development of many varieties at a time. So it is a quite difficult task to calculate the research cost needed for the development of one specific variety. So, the cost should be maintained carefully from the beginning of each research.

Undertaking good quality impact assessment requires good data especially on adoption rate. Adoption information is important not only for rate of return studies but also for information feedback to researchers about how well a technology is being accepted, the determinants of adoption (who is adopting or not adopting and why) and the distribution of the adopted varieties. These are issues that need to be brought to the attention of researchers, extension personnel and policy makers.

REFERENCES

Akino M and Hayami Y. 1975. Efficiency and Equity in Public Research: Rice Breeding in Japan's Economic Development. American Journal of Agricultural Economics, Vol.57;1-10

Akino JM, Norton GW and Parecy PG. 1995. Science Under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting. Comell University Press, Ithaka.

Alston JM, Norton GW and Pardey PG. 1995. Science under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting Cornell University Press, Ithaka.

WRC. 2005. Annual Research Report, Wheat research Centre, BARI, Nashipur, Dinajpur, Bangladesh

WRC. 2006. Annual Research Report, Wheat research Centre, BARI, Nashipur, Dinajpur, Bangladesh

BARI. 2006. Annual Research Report, Agricultural Economics Division , BARI, Joydebpur,Gazipur, Bangladesh

BBS. 1998. Statistical Year Book of Bangladesh 1997, Bangladesh Bureau of Statistics, Ministry of Planning, GOB, Dhaka, Bangladesh.

BBS. 2005. Statistical Year Book of Bangladesh 1997, Bangladesh Bureau of Statistics, Ministry of Planning, GOB, Dhaka, Bangladesh.

BBS. 2005. Statistical Year Book of Bangladesh 1997, Bangladesh Bureau of Statistics, Ministry of Planning, GOB, Dhaka, Bangladesh.

Currie JM, Murphy JA and Schmitz A. 1971. The Concept of Economic Surplus and Its Use in Economic Analysis. Economic Journal. 18: 741.798.

Dey M and Norton G. 1993. Analysis of Agricultural Research Priorities in Bangladesh, BARC, ISNAR.

Gardiner JC, Sanders JH and Barker TG. 1986. An Economic Evaluation of the production Soft Red Winter Wheat Program. Department of Agricultural Economics, Agricultural Experimental Station, Purdue University West Lafayette, In).

Nagy JG. 2000. The final report, The Impact of Agricultural Research in Bangladesh: Estimate Returns to Agricultural Research, 45-55.

Nagy JG. 1991. Returns from agricultural research and extension in wheat and Maize in Pakistan. In Evenson and Pray (eds.) Research and Productivity in Asian Agriculture, Cornell University Press, Ithaca, New York.

Peterson WL. 1971. The returns to investment in agricultural research in the United States. In Resource Allocation in Agricultural research. Edited by W.L. Fishel, University of Minnesota Press.

Appendix 1: Wheat area, production, and prices

Year	Production (thousand MT)	Area thousand ha	Yield (Ton/ha)	Harvest price (Tk./MT)	Import price (Tk./MT)
1993	1,176	637	1.85	5186	6244
1994	1,131	615	1.84	7444	6002
1995	1,245	639	1.95	7463	5842
1996	1,369	701	1.95	7309	6250
1997	1,454	708	2.05	8040	7098
1998	1,803	805	2.24	8200	7027
1999	1,908	883	2.16	8860	7101
2000	1,840	832	2.21	8550	6562
2001	1,673	773	2.16	8705	8988
2002	1,606	706	2.27	9000	8993
2003	1,506	706	2.13	9250	14086
2004	1,253	642	1.95	9500	15787
2005	975	558	1.75	12500	18336
2006	772	481	1.60	14500	20885
2007	746	371	2.01	18500	23434

Source:BBS