Impact analysis of beef cattle agribusiness on income: A double difference approach

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Abstract

This study examined the impact on income of small-scale beef cattle enterprise in Pabna and Sirajganj districts. Data were obtained from 180 cattle fattening participant farmers and 180 non participant farmers from two areas in January and December 2014. Data were collected through the use of structured survey schedules and analyzed by the use of descriptive statistical tools such as means and percentages and also paired t-statistics and chow test were used for the data analysis The Double-Difference (DD) estimator is used to estimate changes in income from before to after benefiting from beef cattle agribusiness between participant farmers and non-participant farmers. Result shows that the net farm income of beef cattle agribusiness entrepreneur increases from BDT 6791.17 before participant to BDT 10289.65 after participant of cattle fattening. There was also an increase in the net farm income of the non-participant farmers from BDT 6750.01to BDT 8437.51during beef cattle agribusiness study. On the average, the net farm income of participant farmers increased by 51.52% and non-participant increased by only 25.0%. The mean increased income was significantly different between participants and non-participant farmers of beef cattle fattening at 10% level of significance. Chow test analysis showed a significant change between the coefficients and intercept of the respondents' income implying that beef cattle agribusiness contributed positively to the increased income realized by the farmers over that of non-farmers. Hence, it can be conducted that beef cattle agribusiness has positive impact on income of the farmers. The study recommends intensive support services from government and non government institutions to improve the performance of the beef cattle agribusiness.

Keywords: Impact, Beef cattle, Agribusiness, Double difference method, Income

Introduction

Livestock agribusiness plays a significant role in our economy through contributing to poverty eradication by creating rural employment and to gear up the achievement of higher economic growth. Livestock is an integral component of agricultural economy of Bangladesh. It is a performing important functions such as food, nutrition, income generation, savings, draft power, manure, fuel, transport, Muslim festival *Eid-ul-Azha* and earning foreign currency by exporting meat, hides and value added waste products, etc. About 36% of the total animal protein comes from the livestock and the rest 64% come from poultry, fish and others. Bangladesh has huge number of livestock and poultry population with very high density but low productivity. Bangladesh has about 23.34 million cattle, 1.45 million buffalos, 25.28 million goats, 3.14 million sheep, 249.00 million chicken and 47.25 million ducks (BER, 2014). Beef cattle are the important and potential sub-sector to economic development, where this sub-sector has a strategic value to fulfill the human need through progressively increase per capita income. However, there seems to have been a significant turnaround in beef cattle production in the past year as indicated by the huge supply of local breeds of cattle in the local markets for consumption during *Eid* festivities. Yet the country has a big deficiency in the supply of meat. According to the Department of Livestock Services (DLS), with per capita daily requirement for meat at 120 gm, the annual demand for meat in Bangladesh is 6.4 million tons, but it produced only 1.98 million tons in the year 2012, leaving a shortfall of nearly 4.4 million tons. Around 3.7 million cattle are slaughtered annually in the country, a fifth of which are imported. Beef cattle agribusiness has significant positive impact on income and employment and poverty reduction in our country. In Bangladesh, incomes and productivity in rural areas are low hence rural populations remain poor. There is also large income inequality with the top 10% of the income bracket accounting for close to total consumption of food and services (Adeolu *et al.,* 2004). Smallholder agriculture the dominant occupation of rural northern part of Bangladesh is mainly rain fed, characterized by poor capital formation and low productivity. Yet, Bangladesh has a potential comparative advantage in the production of a variety of fresh and processed high value meat throughout the year. An impact evaluation of beef cattle business has been undertaken by many researchers and based on some of their findings on the intervention, it was established that the intervention have both positive and negative effects on the farmers as a way of improving on the positive effect of the cattle farming and also to correct some of the

lapses of the agribusiness. However, there is paucity of information to ascertain the impact of beef cattle agribusiness on the income of participant- farmers in study area. The empirical evidence shows that livestock rearing has a positive impact on equity of income and employment for poor households as distribution of livestock assets is more egalitarian as compared to land (Ali, 2007; Birthal and Ali, 2005; Birthal and Singh, 1995; Rao *et al.*, 2003; Sinngh and Hazell, 1993). The ongoing global climate changes and erratic nature of river erosion have often affected crop production in the immediate past few years. Hence, livestock has become a source of dependable income for poor farmers.

The specific objectives of the study were;
i) To examine the income of participant and non-participant farmers of beef cattle agribusiness
ii) To identify the impact on income of beef cattle agribusiness in the study area

Hypotheses

Ho: There is no significant difference between the income of beef cattle agribusiness participant and non participant farmers.
Ho: There is no difference impact between participant and non participant farmers.

The major contribution of this study is to support policy makers in implementing economic policies for sustainable beef cattle production system. Furthermore, the emphasis is to improve natural resource management and identifying factors for structural improvements. The main focus is to attain long term development in livestock sector which will bring growth in rural areas as well as in national economy.

Material and Methods

The study was carried out at Shatia upazila of Pabna and Raigonj upazila of Sirajganj districts of Bangladesh. Multistage sampling technique involving three stages was employed in the selection of the respondents for this study. The first stage involved purposive selection of one upazila each from the two districts because it has plenty of indigenous beef cattle. Moreover, the income of the majority farmers depends on livestock. The area has a lot of crop residuals and by-products useful for feeding and fattening the cattle. The next stage was purposive selection of two groups each from the two selected upazila based on the intensity of cattle fattening activities. The final stage involved the selection of farmers' participant and non-participants of beef cattle agribusiness. The selection of these respondents was assisted by the list of other participants and non participant farmers given by the local NGOs (BASA) and Pabna meat processing company. The sample size was 360 comprising 180 participants of beef cattle agribusiness and 180 non-participants and data collection period was January to December 2014.

Analytical techniques

Farm income evaluates and compared the income of beef cattle agribusiness participants and non-participant farmers in the study area**.** The model specification for the net farm income is as follows:
NFI = GFI – TVC – TFC -- (1)
Where
NFI = Net Farm Income
GFI = Gross Farm Income
TVC = Total Variable Cost
TFC = Total Fixed Cost

Note: % change in income = $\dfrac{\text{Income After} - \text{Income Before}}{\text{Income Before}} \times 100$ ---------------(2)

The cross-sectional comparisons of farmers' household income in agribusiness with those without the project cannot completely attribute difference in income to programme intervention as such the study also employed quasi-experiment using difference in difference estimator (Double difference) method to assess the impact of beef cattle agribusiness on income of participant farmers. The quasi-experiment is one of the impact assessment methods which involved selection of respondents that participated in a beef fattening (participant) and the non-participant (non-participant) from the same location who have similar observable characteristics. (Baker, 2000, Chen *et al.*, 2006, Nkonya *et al.,* 2008). The double-difference analytical tool is a quantitative method often used to estimate and compare change in outcome pre and

post program for participant and non-participant (Chen *et al.,* 2006). The advantage of using the double difference method is that it nets out the effects of additive factors that have fixed (time-invariant) impacts on income indicator, or that reflect common trends affecting participants and non-participants equally such as changes in prices (Ravallion, 2005). The Double-Difference method, which is also known as Difference-in-Difference method (Duflo *et al.*2004, Verner *et al.*, 2005) has the following formula:

$$DD = \left[\frac{1}{P} \sum_{i=1}^{p} (Y_{1ia} - Y_{1ib}) \right] - \left[\frac{1}{C} \sum_{j=1}^{c} \left(Y_{0ja} - Y_{0jb} \right) \right] \text{--------------(3)}$$

Where
DD = Income difference between the respondents
P = number of participants
C = number of individual control group (non –participant)
Y_{1ia} = Income variable of participant after the beef cattle agribusiness
Y_{1ib} = Income variable of participant before the beef cattle agribusiness
Y_{0ja} = Income variable of non participant after the agribusiness
Y_{0jb} = Income variable of non participants before the agribusiness
The level of significance of the income difference was tested using paired t-test as specified:

$$\hat{X}_1 = X_i - \overline{X} \text{ --- (4)}$$

$$\hat{Y}_i = (Y_1 - \overline{\overline{Y}}) \text{ ---(5)}$$

Then t is defined as

$$t = (\overline{X} - \overline{Y}) \sqrt{\frac{n(n-1)}{\sum_{i=1}^{n}(\overline{X}_i - \overline{Y}_i)^2}} \text{ ---(6)}$$

Where,

$\overline{X}_1$ and $\overline{Y}_1$ = two paired sample of participant farmers and non- participant farmers income respectively
n = sample size
n – 1 degree of freedom

Chow test was also carried out to test change in the slope and equality in intercept of the income function of participant farmers and non-participant farmers. In beef cattle agribusiness evaluation, the Chow test is often used to determine whether the independent variables have different impacts on different subgroups of the population. Chow test is variation of F-test for a restriction. In using the chow test, four sets of regression analysis using all the observations of the respondents was carried out and the residual sum of squares of the lead regression model was used for the test. The first regression was on the participant farmers, the second on the non participant, the third on the pooled data of both respondents and the fourth involved inclusion of dummy variable (1and 0 for participant and non participant farmers respectively). The model for the chow test for homogeneity of slope is as follows:

$$F^*\text{Chow} = \frac{RSS_3 - (RSS_1 + RSS_2)/K}{(RSS_1 + RSS_2)/n_1 + n_2 - 2K} \text{ --(7)}$$

Where
RSS_3=Residual sum of squares for the 3rd regression (pooled data)
RSS_1=Residual sum of squares for the first regression (participant group)
RSS_2=Residual sum of squares the 2nd regression (non participant group).
K=is the total number of regression estimates including the intercept b_o n_1 and n_2 = number of observations of the1st and 2nd regression (participant and non participant farmers) respectively.

To test if the coefficients of the estimated differed significantly between the respondents, a dummy variable (1, 0 = represents beef cattle farming participant and non-participant, i.e participant and non participant) was introduced to the pooled data of the regression model. The chow test is given as:

$$F^* = \frac{RSS_3 - RSS_4/K_3 - K_4}{RSS_4/K_4} \text{ --(8)}$$

Where,

$K_3 = n_3 - m$ degree of freedom

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n_3 = number of observations of the 3rd regression

n_4 = number of observations of the 4th regression

m = number of regression estimates including intercept b_o

RSS_3 = Residual sum of squares for the 3rd regression (pooled data)

RSS_4 = Residual sum of squares for the 4th regression (pooled + dummy data)

The computed chow statistics was then compared to the tabulated chow F ratio.

If Fcal > Ftab at F 0.05, then the difference in income between participant and non participant's is due to beef cattle fattening intervention.

Results and Discussion

Farm income analysis

The average costs incurred and the output in monetary value obtained per hectare by the cattle fattening participants and non-participants before and after the beef cattle agribusiness as well as percentage change in income due to cattle business intervention is presented in Table 1. As shown in Table 1, the average total cost of production of participants and non-participants before beef cattle agribusiness was BDT 26,367.45 and BDT 26,207.66 respectively, while their net farm income was BDT 6791.17and BDT 6750.01 respectively. Also the cost of production of the participants and non participants after the beef cattle agribusiness was BDT 40, 457.96 and BDT 33,175.53 respectively. Furthermore, the net farm income for the project participants and non-participants after beef cattle agribusiness was BDT 10,289.65 and BDT 8437.51 respectively. The results indicate an increase in the net farm income of both groups after beef cattle agribusiness, but the net farm income of the participants was higher (51.52%) than that of the non participants (25%).

Table 1. Impact on income of beef cattle agribusiness

Items	Participant Farmers		Non- Participant Farmers	
	Before	After	Before	After
A. Variable Cost				
Purchase of Calve/cattle	19231.58	29,138.76	19115.02	23893.78
Marketing tolls(*Hashil*)	198.00	300.00	196.80	246.00
Feed cost	3254.30	4,930.76	3234.58	4043.22
Labour Cost	373.26	565.55	371.00	463.75
Drug/Vaccine/Veterinary cost	496.74	752.63	493.73	617.16
Transportation cost	146.88	222.54	145.99	182.48
Ropes	47.37	71.77	47.08	58.85
Commission	330.55	500.83	328.54	410.68
Insurance cost for cattle	192.32	291.39	191.15	238.94
Interest on capital	1967.31	2,980.77	1955.38	2444.23
Miscellaneous	129.16	195.69	128.37	160.47
Total Variable cost (TVC)	**26367.45**	**39,950.69**	**26207.66**	**32759.57**
B. Fixed cost				
Feeders	36.76	55.69	36.53	45.67
Drinkers	23.56	35.69	23.41	29.27
Rakes	6.32	9.57	6.28	7.85
Spade	9.47	14.35	9.41	11.77
Tubewell	67.98	103.00	67.57	84.46
Shade	77.02	116.69	76.55	95.69
Bucket	18.97	28.74	18.85	23.57
Land Rent	94.74	143.54	94.16	117.70
Total Fixed cost (TFC)	**334.80**	**507.27**	**332.77**	**415.96**
Total cost (A+B)	**26702.25**	**40,457.96**	**26540.42**	**33175.53**
D. Revenue				
Selling Price	33130.90	50,198.33	30930.10	41162.63
Sales of Manure	362.52	549.28	360.33	450.41
Total Revenue	**33493.42**	**50,747.61**	**33290.43**	**41613.04**
Gross Farm Income	7125.97	**10,796.92**	7082.78	8853.47
Net farm income	**6791.17**	**10289.65**	**6750.01**	**8437.51**
% change in income	**51.52%**		25.0%	

Source: Field survey 2014

The higher difference in net farm income of the participants over that of non participants may be attributed to the increase in the farm output realized by the participants after beef cattle agribusiness. Nevertheless, the net farm income realized by the respondents before beef cattle farming intervention is above the average rural household income of BDT4005.75. The difference in income with respect to the participants after beef cattle agribusiness was significant at 1 % level of probability as shown in Table 2.

Table 2. Test of difference in net farm income between participants and non-participants

Variable	Participant					Non-Participant				
	Mean	Std	t-value	p-value	SE	Mean	Std	t-value	p-value	SE
Total Cost	13755.71	70966.38	4.05	0.006**	4,944.46	6635.11	48748.49	2.82	0.052 *	3396.46
Total Return	17254.19	32813.56	0.31	0.000***	2,286.53	8322.61	19283.52	0.30	0.000 ***	1343.54
Net farm Income	4005.75	74968.49	0.75	0.000***	2,289.17	7762.50	18126.11	0.29	0.000 ***	1256.40

*, ** and *** = Significant at 10%, 5% and 1% level of probability respectively

Impact of beef cattle agribusiness on participant farmer's income

The result of the double difference impact analysis is as shown in Table 3. As indicated in the table, the mean income difference of the participant farmers and non-participant farmers before and after the agribusiness intervention was BDT 221696.59 and BDT 66210.54, and was significant at 1% respectively. As also indicated in table 3, a positive mean double income difference of about BDT 17035.37was realized between participants and non participants before and after agribusiness. The difference in income was significant at 10% level. The finding implied that there was an impact of the project intervention on participant farmers' income in the study area.

Table 3. Double difference estimates impact income of participant beef cattle farmer

Variable	Mean Difference	Standard Deviation	t-statistics
Participant	221696.59	23082.40	7.83***
Non-participant	66210.54	48962.65	6.358***
Double Difference	17035.37	71078.15	0.88*

Source: Field Survey, 2014 *, and *** = Significant at 10%, and 1% level of probability

The coefficients of beef cattle agribusiness on income

Table 4 shows the result of analysis of variance (ANOVA) of the values of the residual sum of squares of the lead equation of four regression analysis carried out. The computed F*Chow statistics was 219.12, with v^1 =3 and v^2 = 141 degree of freedom and F tabulated at 5% level of significance is 2.01. This implied that there is difference between the coefficients of beef cattle farming participant and non participant farmers' income function since the F*Cal is greater than F tabulated hence the null hypothesis was rejected. Furthermore, for test of homogeneity of slope, F*Chow statistics was 79.48, with v^1 = 2 and v^2 = 140 degree of freedom at 5% level of significant and F tabulated is 2.10 confirming the heterogeneity of slopes of participant and non participant hence indicating a positive impact of beef cattle agribusiness on the participant farmers income.

Table 4. Analysis of Variance (ANOVA) Result

Model	Error sum of square	Degree of freedom	Mean Square	F-ratio
Participant Farmers				
Regression	178360.00	2	29725.5	6.17***
Residual	335405.00	70	1685375	
Total	513800.00	72		
Non- Participant Farmers				
Regression	218190.00	2	31167.5	4.94***
Residual	891800.00	70	2207839	
Total Pooled	1110200.00	72		
Regression	217980.00	2	36330	5.77***
Residual	892150.00	142	2202905	
Total	1110200.00	144		
Pooled with dummy				
Regression	164290.00	3	27380.5	5.46***
Residual	349440.00	141	1756028	
Total	513800.00	144		

Source: Field Survey, 2014 *** = 1% level of significance

Conflict of Interests

We declare that we have no financial and personal relationships with other people or organizations.

Conclusion

Beef cattle value chains of Northern Bangladesh were greatly influenced by scale of production with cattle from large scale producers going through cattle fattening and with fewer actors than cattle from small scale producers. Beef cattle based economic activity is considered to have a promising prospect in the future. North Bengal of Bangladesh is potential area for development of beef cattle agribusiness as it has potential resources including land availability, feed animal population, human resources, and demand of animal products. Demands of beef come from both domestic and foreign markets. From the findings of the study, it has been positive impact on income of the participant farmers increased significantly more than before the beef cattle agribusiness and also more than the non-participant farmers' income. Double difference analysis result further proved the fact that the increase in income realized by the participant farmers was attributed to their participation in beef cattle agribusiness based on the positive mean income value obtained which was significant at 10 % level of probability. The Chow test analysis shows that there was inequality and heterogeneity in the coefficients and slope respectively between participant farmers and non-participant farmers' income function. Hence the null hypothesis is rejected. Based on the findings drawn from this study the following underlying recommendations are made for improvement of beef cattle agribusiness. The study recommends sustainable and quality of business services such as technology, inputs and finance and training of farmers to use those services beef cattle agribusiness effectively and profitability that means of increasing farmers' income in further. Support services should be based on participatory rural appraisal in identification of beef cattle agribusiness problems and come up with solutions based on market demand. From a careful analysis of the impact of the beef cattle sub-sector in study areas, researchers recommend the following important points should be taken under consideration for improving beef cattle agribusiness by the responsible bodies in the country:

(i)   Potential areas of beef cattle production should be well identified and scaled up further.
(ii)   Adopt a value chain approach in development of the beef cattle sub-sector
(iii)   Address information gaps for effective planning and monitoring of performance
(iv)   Develop programs for increased productivity of the livestock sector
   o   Create awareness on the causes of low productivity and implications on overall returns
   o   Improve delivery of animal health and animal production services among farmers.
   o   Improve farmer acquisition of high quality breeds
(v)   Explore entry points for introduction of commercial livestock production
(vi)   Capacity building of the beef cattle entrepreneur
   o   Improve access to business support services
   o   Support development of infrastructure for processing of livestock products and by-products

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