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Relative profitability of farming systems research and development (FSRD) project farmers and non-project farmers of integrated farming systems in Tangail district of Bangladesh

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Abstract

Integrated farming system modifies the commercial farming system which ensures higher food production to equate the demand, environmental protection through effective recycling of waste and increased farm income. The present study was undertaken to examine the relative profitability of FSRD project farmers and non-project farmers of integrated farming system. Eighty (80) farmers (40 from FSRD project and 40 from non-project farmers) were selected from Kalihati Upazila under Tangail district of Bangladesh. In the study area, vegetables, fish and poultry enterprises were integrated under technological intervention. The waste of poultry farm was used in fish production and the soil of the pond was used in vegetables cultivation. Per hectare net returns from integrated farming were estimated at Tk513458.10 and Tk256511.90for FSRD project farmers and non-project farmers, respectively. Benefit cost ratio (BCR) was 1.66 for FSRD project farmers and1.37 for non-project farmers. In functional analysis, human labor, fingerling, feed, fertilizer, insecticides costs in case of FSRD project farmers and human labor, feed, salt and lime costs in case of non-project farmers had significant impact on per hectare return of integrated farming. FSRD project farmers were more profitable than the non-project farmers. Therefore, it can be concluded that there is great scope to improve the overall economic condition of farmers through introducing integrated farming system in Tangail District of Bangladesh.

Introduction

Agriculture has been playing a pioneering role in the growth and stability of the national economy of Bangladesh. Bangladesh is the biggest delta landscape in the world with a large human and natural resources (Mondal *et al*., 2002). It is often argued that the future development of Bangladesh depends particularly on the agriculture sector which includes crops, livestock, fisheries and forestry. Bangladesh is one of the most densely populated countries in the world, which has only about 87, 51, 937 hectares of cultivable land to feed its 160 million population (BBS, 2015). The land area is gradually decreasing because of population growth, industrialization and infrastructure development. Traditional farming is risky and farmers invest heavily in crop production to get utmost return. With increasing pressure from the growing human population, only vertical expansion is possible by integrating appropriate farming components, requiring lesser space, time and ensuring periodic income to the farmer (Mamun *et al*., 2011).

Integrated farming is a farming system with simultaneous activities involving crop, fisheries and livestock. The purpose of integrated farming is that the farming components support one another. Integration of various agricultural enterprises viz., cropping, animal husbandry, fishery, forestry is important in agricultural economy (Jayanthi *et al.*, 2002). Wastes or by-products from each enterprise are used as inputs for other enterprises to improve productivity and lower the cost of production. Integrated farming is generally considered beneficial for the rural poor (Vincke, 1991).This system assumes greater importance for the sound management of farm resources which enhances the farm productivity, reduces the environmental degradation and improves the quality of life for poor farmers and to maintain sustainability (Uddin, 2004).

Bangladesh Agricultural Research Institute has developed a number of technologies which can be used for increasing production and income of the farmer. Department of Agriculture Extension, on-farm research division (OFRD) of Bangladesh Agricultural Research Institute (BARI) and many NGOs are trying to disseminate these technologies among the farmers. Integrated farming activities were carried out at Farming Systems Research and Development (FSRD) sites of Rangpur, Pabna, Faridpur and Tangail to utilize available farm resources to improve livelihood of the resource poor farm households. The FSRD project provides seed, feed, training to the farmers. In the study

area, components of integrated farming such as vegetables, fish and poultry were brought under technological intervention and income increased from these components. The basic principles involved in integrated farming are the utilization of the synergetic effects of inter-related farm activities, and the conservation, including the full utilization of farm wastes (Mahbub, 2013). In study area, the waste of poultry sector is used in fish production and the soil of the pond is used in vegetables cultivation. However, this study was undertaken to assess the relative profitability of FSRD project farmers and non-project farmers of integrated farming systems. Effects of variable inputs to gross return from integrated farming were also determined.

Materials and Methods

Area selection, selection of sample and sampling technique

The area in which a farm survey has to be carried out depends on the purposes of the survey and possible co-operation from the farmers (Yang, 1965).To achieve the objectives, total 80 farmers (40 project farmers and 40 non-project farmers) were randomly selected from three villages under Kalihati Upazila of Tangail district in Bangladesh for the study. All the project and non-project farmers of the study area were found to practice fish, vegetable and poultry enterprises. A structured interview schedule has been used in this study to collect necessary primary data from the sample respondents.

Table1. Distribution of the sample farmers across the study areas of Kalihati Upazila under Tangail district

Type of farmers	Chinamura	Musinda	Ishapur	Total
FSRD project farmers	15	15	10	40
Non-project farmers	15	15	10	40
Total	30	30	20	80

Source: Field survey, 2015

To satisfy the objectives of the study, necessary data were collected through personal interviews with the sample farmers during March to May 2015.

Analytical Technique

Data were analyzed with a combination of tabular and functional analysis. Per hectare profitability of FSRD project farmers and non-project farmers of integrated farming was measured in terms of gross return, gross margin, net return and benefit cost ratio (undiscounted). Cobb-Douglas production function was used to see the effect of variable inputs to gross return.

Gross return (GR)

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). The gross return was estimated as follows:

Gross return, $GR = \Sigma QP$……...…….(1)

Where, GR = Gross return from product (Tk. /ha);Q = Quantity of the product; P = Average price of the product.

Gross margin (GM)

Gross margin was calculated by subtracting the total variable costs from the gross return, showed in the following equation.

$GM = \sum GR\text{-}TVC$…….....…….(2)

Where,
GM = Gross margin; GR = Gross return; and TVC = Total variable cost.

Net return (NR)

Net return was calculated by deducting total costs from gross return as shown in the equation 3. To determine the net return of integrated farming, the following equation was used in the present study:

Net return, $NR = \sum(GR - TC)$……..(3)
Where,
GR = Gross return; and
TC = Total cost.

Benefit cost ratio (BCR)

The benefit-cost ratio (BCR) is a relative measure which is used to compare benefit per unit of cost. BCR was estimated as a ratio of gross returns to total costs. The formula of calculating BCR (undiscounted) is shown as below:

$$\text{Benefit cost ratio, (BCR)} = \frac{\text{Gross return}}{\text{Total cost}} \text{..... (4)}$$

Functional analysis

To explore the input-output relationship of integrated farming, the following Cobb-Douglas production function model was used where only the important variables were considered. Some factors such as vaccination of poultry, pond maintenance cost and electricity cost of lighting were considered as miscellaneous cost and these were excluded from the functional analysis.

$$Y=aX_1^{b1}X_2^{b2}X_3^{b3}X_4^{b4}X_5^{b5}X_6^{b6}X_7^{b7}X_8^{b8}X_9^{b9}U\text{..... (5)}$$

The above function was linearized as follows:
$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8 \ln X_8 + b_9 \ln X_9 + U$
Y = Gross return from integrated farming (Tk. /ha.);
X_1 = Human labour (Tk. /ha.);X_2 = Cost of fingerlings (Tk./ha.); X_3 = Cost of seeds (Tk. /ha.);
X_4 = Day old chick cost (Tk.) X_5 = Cost of Feed (Tk. /ha.); X_6= Cost of fertilizer (Tk. /ha.); X_7= Cost of lime and salt (Tk. /ha.); X_8= Cost of insecticides (Tk. /ha.); X_9= Cost of irrigation (Tk. /ha.); a = Intercept; b_1– b_9= Co-efficients of the relevant variables; In = Natural logarithm; and U = Disturbance term.

Results and Discussion

Profitability of integrated farming

The focus of this study is to assess the costs, returns and profitability of integrated farming of FSRD project farmers and non-project farmers. All costs and returns were calculated for the duration of one year operation of the integrated farming. The cost of using human labour, fingerlings, seeds, day old chick cost, feed, fertilizer, manure, lime, salt and medicine, irrigation cost, insecticides, fencing, land use cost , depreciation on tools and equipment, housing cost, family labour cost, interest on operating cost were estimated.

Table 2. Per hectare cost of integrated farming (fish-vegetables-poultry)

Cost Item	FSRD project farmers		Non-project farmers	
	Cost (Tk.)	Percentage	Cost (Tk.)	Percentage
Hired labour cost	179183.70	23.3	171421.80	24.7
Fingerlings	58196.10	7.5	42607.60	6.1
Seeds	8619.70	1.1	7712.80	1.1
Day old chick cost	6590.40	0.8	7280.50	1.0
Feed	333524.90	43.4	294738.90	42.5
Fertilizer	13692.80	1.7	12780.30	1.8
Manure	9873.50	1.2	8451.20	1.2
Lime	2433.90	0.31	2304.70	0.33
Salt and medicine	4885.70	0.63	3265.30	0.47
Irrigation cost	27863.20	3.6	24376.10	3.5
Insecticides	3978.30	0.5	3784.50	0.54
Fencing	1896.50	0.24	1572.50	0.22
Miscellaneous	2721.40	0.35	2570.20	0.37
Total Variable Cost	653460.10		582866.40	
Land use cost	61750.80	8.01	61400.50	8.7
Depreciation on tools and equipments	11254.70	1.46	10240.90	1.47
Housing cost	1550.60	0.20	1760.89	0.25
Family labour cost	950.50	0.12	1035.50	0.15
Interest on operating cost	39207.60	5.1	34971.98	5.05
Total Fixed Cost	114714.20		109409.80	
Total cost	768174.30	100	692276.20	100

Source: Field survey, 2015.

Hired labour cost

Hired labour is one of the most important costs and largely used inputs in integrated fish-vegetables-poultry farming. In the study area, the average wage rate was Tk. 300.00 per man-day including meal. Cost of hired labour per hectare was estimated at Tk. 179183.70 which constituted 23.3 percent of total cost of integrated farming for FSDR project farmers whereas; it was estimated at Tk. 171421.80 which was 24.7 percent of total cost for non- project farmers in the study areas (Table 2).

Cost of fingerlings

Cost of fingerlings per hectare in integrated farming was at Tk. 58196.10 which constituted 7.5 percent of total cost of integrated farming for FSDR project farmers whereas; it was estimated at Tk. 42607.60 which was 6.1 percent of total cost of integrated farming for non-project farmers (Table 2).

Cost of feed

Feed is the major cost of the integrated farming. Cost of feed per hectare was estimated at Tk. 333524.90 which constituted 43.4 percent of total cost of integrated farming for FSDR project farmers whereas; it was estimated at Tk. 2294738.90which 42.5 percent of total cost of integrated farming for non-project farmers (Table 2).

Cost of seeds

The cost of purchased seeds and seedlings was calculated on the basis of actual price paid by the farmers. Per hectare cost of seed were estimated at Tk. 8619.70which was 1.1 percent of total cost and Tk.7712.80 which was 1.1 percent of total cost for FSDR project farmers and non- project farmers, respectively (Table 2).

Day old chick cost

Day old chick cost were estimated at Tk.6590.40which was 0.8 percent of total cost and Tk. 7280.50 which was 1.0 percent of total cost for FSDR project farmers and non- project farmers, respectively in the study areas (Table 2).

Cost of fertilizer

Farmers used Urea, TSP and MoP as fertilizer. Cost of fertilizer was estimated at Tk. 13692.80and Tk.12780.3per hectare for FSDR project farmers and non-project farmers, respectively in the study areas (Table2).

Cost of lime

Lime is an important factor for increase fish production as well as the return of integrated farming. Costs incurred for lime was Tk. 2433.90 per hectare for FSRD project farmers and Tk. 2304.70 per hectare for non-project farmers (Table 2).

Cost of salt and medicine

Farmers used salt at the time of cleaning their pond. Medicine is also used in both fish and poultry sector in integrated farming. Per hectare cost of salt and medicine were estimated at Tk. 4885.70 which was 0.63 percent and Tk. 3265.30 which was 0.47 percent of total cost for FSDR project farmers and non-project farmers, respectively (Table 2).

Cost of insecticides

Most of the sample farmers used insecticides in producing vegetables. Cost of insecticides per hectare in integrated farming was at Tk. 3978.30 which constituted 0.53 percent of total cost of integrated farming for FSDR project farmers whereas; it was estimated at Tk. 3784.50 which was 0.54 percent of total cost for non-project farmers (Table 2).

Cost of manure

Cost of manures per hectare in integrated farming was at Tk. 9873.50 which constituted 1.1 percent of total cost of integrated farming for FSDR project farmers

whereas; it was estimated at Tk. 8451.20 which was 1.2 percent of total cost of integrated farming for non-project farmers in the study areas(Table 2).

Cost of irrigation
Irrigation was an important factor for both fish and vegetables production. Cost of irrigation per hectare was estimated at Tk. 27863.20 which constituted 3.6 percent of total cost of integrated farming for FSDR project farmers whereas; it was estimated at Tk. 24376.10 which was 3.5 percent of total cost for non-project farmers (Table 2).

Cost of fence
Bamboo, rope and other sticks were used for making fencing the vegetables plots. Cost of fencing per hectare in integrated farming was at Tk. 1896.50 for FSDR project farmers and Tk. 1572.50 for non-project farmers (Table 2).

Miscellaneous cost
Farmers have to incur many other costs. These costs are cost of marketing, fishing gear, harvesting equipment of vegetables, pond maintenance cost, electricity cost and vaccination cost. It is evident from Table 2 that in case of FSRD project farmers, per hectare miscellaneous cost was Tk. 2721.40 which was 0.35 percent of total cost. On the other hand, it was estimated at Tk. 2570.20 which was 0.37 percent of total cost in case of non-project farmers.

Land use cost
Land use cost varies from place to place depending on the location, soil fertility, topography of the soil. Considering the entire sample farmers, Table 2per hectare land use cost per year incurred integrated farming was Tk.61750.80 for FSRD project farmers. On the other hand, land use cost was estimated at Tk. 61400.50 for non-project farmers.

Depreciation on tools and equipment
Depreciation on tools and equipment per hectare in integrated farming was Tk. 11254.70 which constituted 1.46of total cost for FSDR project farmers whereas it was estimated at Tk. 10240.90 which was 1.47 percent of total cost for non-project farmers (Table 2).

Housing cost and Family Labour cost
Housing cost and family labour cost were estimated at Tk.1550.60 and 950.50 for FSDR project farmers, whereas 1760.89 and 1035.50 for non- project farmers, respectively (Table 2).

Interest on operating cost
Interest rate of 12 percent per annum was considered for calculation. Interest on operating cost per hectare in integrated farming was at Tk. 39207.60 which constituted 5.1 percent of total cost of integrated farming for FSDR project farmers whereas; it was estimated at Tk. 34971.98 which was 5.05 percent of total cost of integrated farming for non-project farmers in the study areas (Table 2).

Total cost
Total cost was calculated by adding up total variable costs and total fixed costs. Variable cost was included cost of using human labor, fingerlings, feed, day old chick seed, fertilizer, lime, manure, salt and medicine, insecticides, fencing, irrigation cost and miscellaneous cost. Here variable cost Tk. 653460.10 and Tk. 582866.40 for FSRD project farmers and non project farmers. In farming, per hectare total cost was Tk. 768174.30and Tk. 692276.20 for FSRD project farmers and non-project farmers, respectively in the study areas (Table 4).

Gross return (GR)
Gross returns are the total monetary value of integrated farming including combined production of fish, vegetables and poultry was multiplied by their respective prices. Annual gross returns from integrated farming were estimated at Tk. 1281632.40 and Tk. 948788.10 per hectare for the FSRD project farmers and non-project farmers, respectively (Table 3). It can be seen from the table that gross return from FSRD project farmers is higher than the non-project farmers. Gross return from all the three enterprises (fish, vegetables and poultry) is higher in project farmers than non-project farmers due to support and better management by FSRD project.

Table 3. Per hectare gross return (Tk.)of integrated farming (fish-vegetables-poultry)

Items	FSRD project farmers	Non-project farmers
Fish production	8,75,017.90	6,02,745.50
Vegetables	320963.70	268617.80
Poultry	85650.80	77424.70
Total	1281632.40	948788.10

Source: Field survey, 2015.

Table 4. Per hectare Cost and Return of integrated farming (fish-vegetables-poultry)

Items	FSRD project farmers	Non-project farmers
Gross returns (Tk)	1281632.40	948788.10
Total Variable cost (Tk)	653460.10	582866.40
Total cost (Tk)	768174.30	692276.20
Gross margin (Tk)	628172.30	365921.70
Net return(Tk)	513458.10	256511.90
Benefit-Cost Ratio (BCR)	1.66	1.37

Source: Field survey, 2015

Gross margin (GM)
Gross margins of integrated farming per hectare were estimated at Tk. 628172.30 and Tk. 365921.70 for the FSRD project farmers and non-project farmers, respectively (Table 4). So, the FSRD project farmers were more profitable than the non-project farmers.

Net return (NR)
To estimate the net return from integrated farming total cost was deducted from gross return. Net returns of

integrated farming per hectare were estimated at Tk. 513458.10 and Tk. 256511.90for FSRD project farmers and non-project farmers, respectively in the study areas (Table 4). It is evident from the table that net return of the project farmers was significantly higher that non-project farmers. The project farmers received this sort of higher profit due to the various supports from the FSRD projects.

Benefit-Cost Ratio (BCR)

Benefit cost ratio is a relative measure which is used to compare benefits per unit of cost. Benefit cost ratio (undiscounted) is obtained by dividing gross return by total cost. The benefit cost ratio (BCR) of integrated farming for non- project farmers was 1.37 indicating that integrated farming is profitable. On the other hand, the BCR was 1.66 for FSRD project farmers which indicate that, the integrated farming is also profitable (Table 4). However the farmers of FSRD project were more profitable than the non-project farmers. Gilbert *et. al.* (2001) found positive impacts of farming system research on (i) generation and transformation of technology, (ii) employment generation, (iii) gender dimension, (iv) intensity of land use, (v) generation of income and saving and (vi) development of agribusiness.

Functional Analysis

The individual and total effect of inputs on the gross return can be explained by Cobb-Douglas production function analysis. Estimated values of the coefficients and related statistics of the selected variables, for FSRD project farmers and non-project farmers are shown in Table 5.

Table 5. Estimate of the coefficients of the Cobb-Douglas production function for integrated farming systems of FSRD project farmers and non-project farmers

Explanatory variables	FSRD project farmers			Non-project farmers		
	Coefficient	Standard error	t-value	Coefficient	Standard error	t-value
Intercept	4.351	0.808	5.384	3.598	0.906	3.970
Human labor cost	0.067***	0.023	2.891	0.051***	0.018	2.730
Fingerling cost	0.218**	0.095	2.289	0.204	0.351	0.580
Seed cost	0.007	0.031	0.226	-0.028	0.046	-0.604
Day old chick cost	0.001	0.002	0.521	0.017	0.036	0.463
Feed cost	0.379**	0.163	2.331	0.325***	0.089	3.620
Fertilizer cost	0.071**	0.038	1.867	0.042	0.076	0.548
Lime and salt cost	0.0003	0.0004	0.697	0.089*	0.044	1.985
Insecticides cost	0.036*	0.022	1.639	-0.072	0.070	1.024
Cost of Irrigation	0.054	0.069	0.782	0.071	0.085	0.826
R^2		0.771			0.624	
F -value		29.84***			12.28***	
Returns to scale		0.83			0.69	

Source: Authors' estimation, 2015

Note

***Significant at 1 percent level

** Significant at 5 percent level

*Significant at 10 percent level

From the above table it can be concluded that all the variables included in the regression model were important to explain the variation in the gross return of integrated farming. For FSRD project farmers out of nine explanatory variables human labor, fingerling, feed, fertilizer, insecticides costs had positive coefficient and significant contribution to gross return; day old chick cost, seed, salt and lime, cost of irrigation had insignificant contribution to gross return. For non-project farmers, labor, feed, salt and lime costs had positive coefficient and significant contribution to gross return; day old chick cost, fingerling, fertilizer, seed, insecticides, cost of irrigation had insignificant contribution to gross return.

Coefficient of determination (R^2)

The coefficient of determination (R^2) specifies how well the sample regression line fits the data (Mitu, 2013). It is evident from Table 5 that the estimated value of goodness of fit; R^2 of the model was 0.771 and 0.624 for FSRD project farmers and non project farmers of integrated farming, respectively. The R^2 value of 0.771 indicates that about 77 percent of the total variation in gross return of FSRD project farmers of integrated farming has been explained by the variables included in the model. For non-project farmers the R^2 value of 0.624 indicated that about 62 percent of the total variation in gross return of integrated farming has been explained by the variables included in the model.

F-value

The F-value was estimated for overall significance of the model. The F-values of the model derived from FSRD project farmers and non-project farmers of integrated farming were 29.84 and 12.28 respectively, which were significant at 1 percent probability level implying that all the included explanatory variables included in the model

were important for explaining the variation in gross return of integrated farming (Table 5) under both groups.

Returns to Scale

In the present study, the value of the returns to scale was estimated at 0.83 for FSRD project farmers which indicated that if all the inputs specified in this model were increased by 1 percent, gross return of the integrated farming were increased by 0.83 percent and it indicated decreasing returns to scale as it was less than one (Table 5). The value of the returns to scale was estimated at 0.69 for non-project farmers which indicated that if all the inputs specified in the model were increased by 1 percent, gross return of the integrated farming were increased by 0.69 percent. However as it was less than one, it indicates decreasing returns to scale (Table 5).

Conclusion and Recommendation

It is evident from the results of cost and return analysis that both the project and non-project farmers are making profits. The study reveals that the FSRD project farmers are earning higher profits than non-project farmers. It indicates that the efficiency of FSRD project farmers is significantly higher than the non-project farmers. This implies that the non-project farmers have more scope to cope with the FSRD technology. In this connection, the project managers, government and non-government officials, extension workers should, therefore, encourage the farmers to adopt integrated farming system having advice/suggestions from the FSRD thus they can be more benefited from their farming activities which is very important for a low income peasant rural economy.

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