Comparative profitability of sole pineapple, pineapple-papaya and pineapple-banana-arum cultivation in Tangail District of Bangladesh

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Abstract
The focus of the study was to evaluate the comparative profitability of sole pineapple, pineapple-papaya and pineapple-banana-arum cultivation at Madhupur and Ghatail Upazilas of Tangail district in Bangladesh. Data from 90 randomly selected farmers, 30 each from sole pineapple, pineapple-papaya and pineapple-banana-arum categories, were collected through face-to-face interview using a set of pre-tested questionnaires. Profitability analysis was used to estimate the comparative profitability and Cobb-Douglas type production function technique was used to identify the factors influencing gross return. The major findings of the study revealed that sole pineapple, pineapple-papaya and pineapple-banana-arum cultivation in the study areas were profitable, among which, pineapple-papaya cultivation was relatively more profitable than the two other patterns. It was evident from Cobb-Douglas type production function that seed, human labour, fertilizer, insecticide, power tiller and manure had significant impact on gross return from sole pineapple, pineapple-papaya, pineapple-banana-arum production.

Keywords: Sole pineapple, pineapple-papaya, pineapple e-banana-arum, comparative profitability, Bangladesh

Introduction
Bangladesh is an agro-based country and predominantly an agrarian economy (Mohammad, 2012). The agriculture sector contributes 14.79 percent to gross domestic product (GDP) in which 7.92 percent comes from crops and vegetables, 1.60 percent from livestock, 1.66 percent from forestry and 3.61 percent from fisheries (MoF, 2017). Fruits play a vital role in the overall economic performance of Bangladesh. The production of fruits including pineapple is increasing day by day in Bangladesh (Khalil et al., 2011). Apart from the consumption as a juicy and nutritious fruit, pineapple is also referred as a medical diet for certain diseased persons.

Pineapple is originated in Brazil in South America. It was imported to Europe later. It is also believed that Christopher Columbus and his crew members were probably the first few from the European continent to have tasted the fruit. The word pineapple in English was first recorded in 1698, when it was originated, used to describe the reproductive organs of conifer trees (now termed pine cones). When European explorers discovered this tropical fruits they called them pineapples (term first recorded in that sense in 1664) because of their resemblance to what is now known as the pine cone. The term pinecone was first recorded in 1694, and was used to replace the original meaning of pineapple (Gazi, 2013).

Pineapple is one of the major commercial and popular fruits in Bangladesh because of its exclusive flavor, pleasant aroma, delicious taste, nutritional and medicinal values. It is widely cultivated in Tangail, Mymensingh, Gazipur, Sylhet, Moulibazar, Chattagram, Bandarban, Khagrachari and Rangamati districts. At least ninety varieties of pineapple are cultivated in the world. In Bangladesh, however three varieties of pineapple are mostly grown. These are: Giant Kew, Honey Queen, and Ghorasal (Hossain and Islam, 2017). Bangladesh produces 200701 tonnes of pineapple per annum from 33498 acres of land (BBS, 2016). Total area and production of pineapple has increased steadily during the last decades. Pineapple cultivation was found to be profitable in different studies (Hossain, 2018; Fakir, 2017; Swarna, 2017). Mono pineapple and pineapple intercrops study was also found profitable in Tangail district (Gazi 2013). Pineapple cultivation had positive impact on farmers’ livelihood and they showed positive attitude towards pineapple cultivation with intercrops.

The present study focuses on assessing the relative profitability of sole pineapple, pineapple-papaya and pineapple-banana-arum production.
pineapple-banana-arum cultivation in Tangail district of Bangladesh.

Materials and Methods

Selection of study area and sampling technique

The area in which a farm survey has to be carried out depends on the purposes of the survey and possible cooperation from the farmers (Yang, 1965). The present study was based on field survey method where primary data were collected from the respondents through direct interviews. Ninety randomly selected farmers from four villages of Madhupur and Ghatail Upazilas of Tangail district of Bangladesh were interviewed for the present study (Table 1).

Table 1. Distribution of Sample Farmers of the Study Area

| Selected Upazila | Selected villages | Sole pineapple farmers | Pineapple - papaya farmers | Pineapple - banana - arum farmers | Total sample size (No.) |
|-----------------|------------------|------------------------|---------------------------|----------------------------------|------------------------|
| Madhupur        | Gachabari        | 10                     | 10                        | 5                                | 25                     |
|                 | Aushnara         | 5                      | 5                         | 10                               | 20                     |
| Ghatail         | Kusharia         | 5                      | 5                         | 10                               | 20                     |
|                 | Makrai           | 10                     | 5                         | 10                               | 25                     |
| Total           |                  | 30                     | 30                        | 30                               | 90                     |

Source: Field survey, 2015

Analytical Technique

Data were analyzed with a combination of tabular and functional analysis. Per hectare profitability of sole pineapple, pineapple-papaya, pineapple-banana-arum production from the view point of individual farmers was measured in terms of gross return, gross margin, net return and benefit cost ratio (undiscounted). Here we also used Cobb-Douglas type production function to estimate the effects of inputs on gross return.

Gross return

Gross return (GR) 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 following equation was used to estimate GR:

\[ GR = \sum QP \]  

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

Gross margin

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

\[ GM = GR - TVC \]  

Where, 
GM = Gross margin (Tk./ha); GR = Gross return (Tk./ha); and TVC = Total variable cost (Tk./ha).

Net return

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

\[ NR = \sum (GR - TC) \]  

Where, 
GR= Gross return from product (Tk./ha); TC= Total cost (Tk./ha).

Benefit cost ratio (BCR)

The BCR is a relative measure, which is used to compare benefit per unit of cost (Chowdhury et al., 2014). The BCR was estimated as a ratio of gross returns and gross costs. The formula of calculating BCR (undiscounted) is shown below:

\[ BCR = \frac{\text{Gross return}}{\text{Total cost}} \]  

(4)

Functional Analysis

To explore the relationship between input and gross return, the Cobb-Douglas type production function was used. Since the model proved superior on theoretical and econometric grounds, this function was chosen on the basis of the best fit. The following model was used in this study:

\[ Y = aX_1 + b_1lnX_1 + b_2lnX_2 + b_3lnX_3 + b_4lnX_4 + b_5lnX_5 + b_6lnX_6 + U \]  

(5)

The model was made linear in the logarithmic form as follows:

\[ \ln Y = \ln a + b_1\ln X_1 + b_2\ln X_2 + b_3\ln X_3 + b_4\ln X_4 + b_5\ln X_5 + b_6\ln X_6 + b_7 + U \]  

(6)

Where, \( Y \) = Gross return (Tk./ha); \( X_1 \) = Seed cost (Tk./ha); \( X_2 \) = Human labor cost (Tk./ha); \( X_3 \) = Fertilizer cost (Tk./ha); \( X_4 \) = Insecticides cost (Tk./ha); \( X_5 \) = Power tiller cost (Tk./ha); \( X_6 \) = Vitamin cost (Tk./ha); \( X_7 \) = Manure cost (Tk./ha); ln = Natural logarithm; a = Constant/Intercept; \( b_1, b_2, \ldots, b_7 \) = Coefficients of the respective variables; and U = Error term.

Results and Discussion

Cost and Return of Pineapple Production

Estimation of cost was exclusively necessary for enterprise costing and subsequently determining the viability of the enterprise from the viewpoint of producers. The farmers used different inputs for pineapple production.

Cost of human labour

Human labour was considered as the most important and largely used input in producing pineapple. It shared a large portion of total cost of production. Labour required for different farm operations were: land preparation, planting, mulching, weeding, irrigation, insecticide application, application of fertilizer, harvesting, carrying, drying, storing. It could be seen from Table 2 that the cost of human labour for sole pineapple,
pineapple-papaya, pineapple-banana-arum cultivation were Tk. 76300.00, Tk. 87500.00, Tk. 96250.00, respectively.

Cost of power tiller

Power tiller is time and labour saving modern tillage technology. It was used for cultivation of land for pineapple production. It is evident from Table 2 that per hectare power tiller cost for sole pineapple, pineapple-papaya and pineapple-banana-arum cultivation were Tk. 7700.00, Tk. 9500.00 and Tk. 9800.00, respectively.

Cost of seed

Table 2: Total cost and return per hectare for sole pineapple, pineapple-papaya and pineapple-banana-arum production

| Items                      | Sole pineapple | Pineapple-papaya | Pineapple-banana-arum |
|----------------------------|----------------|------------------|-----------------------|
| A. Gross return            |                |                  |                       |
| Pineapple                  | 508000.00      | Pineapple        | 486400.00             |
| Papaya                     | 120312.00      | Banana           | 74000.00              |
| Arum                       |                | Arum             | 40000.00              |
| Total                      | 508000.00      | Total Return     | 606712.00             |
| Human Labour:              |                | Human Labour:    |                       |
| Land preparation           | 17500.00       | Land preparation | 21000.00              |
| Planting, fertilizer       | 25550.00       | Planting, fertilizer | 28000.00          |
| application                |                | application      |                       |
| Weeding                    | 14700.00       | Weeding          | 15750.00              |
| Harvesting and carrying    | 18550.00       | Harvesting and   | 22750.00              |
|                            |                | carrying         |                       |
| Total                      | 76300.00       | Total            | 87500.00              |
| Power tiller               | 7700.00        | Power tiller     | 9500.00               |
| Seedling                   | 63700.00       | Seedling of pineapple | 61200.00         |
|                            |                | Seedling of papaya | 3000.00              |
| Manure: Cow-dung           | 5705.00        | Manure: Cow-dung | 8500.00               |
| Fertilizer: Urea           | 12800.00       | Fertilizer: Urea | 12800.00              |
| TSP                        | 14950.00       | TSP              | 16100.00              |
| MP                         | 9000.00        | MP               | 9750.00               |
| Gypsum                     | 5500.00        | Gypsum           | 4950.00               |
| Total                      | 42250.00       | Total variable cost | 43600.00             |
| Insecticides               | 9681.00        | Interest on operating capital | 19320.00         |
| Vitamin                    | 12312.00       | Interest on operating capital | 19320.00         |
| Fixed Costs                | 217648.00      | Fixed Costs      | 234192.00             |
| Total Fixed Cost (GR-TVC)  | 103907.00      | Total Fixed Cost | 107112.00             |
| C. Gross margin (GR-TVC)   | 321555.00      | Total Cost       | 341304.00             |
| D. Net return (NR)=(GR-TVC)| 290352.00      | C. Gross margin  | 372520.00             |
| E. Benefit cost ratio      | 1.58           | D. Net return    | 265408.00             |
| (GR/TVC)                   |                | (NR)=(GR-TVC)    |                       |
|                            |                | E. Benefit cost ratio | 1.78               |
|                            |                | (GR/TVC)         |                       |

Cost of fertilizer

Application of recommended doses of fertilizer is important for crop production. In the study area, farmers used mainly four types of fertilizer namely Urea, TSP, MP, Gypsum. Table 2 showed that per hectare cost of urea, TSP, MP and gypsum for sole pineapple were Tk. 12800.00, Tk. 14950.00, Tk. 9000.00, Tk. 5500.00, respectively. Per hectare cost of above mentioned four fertilizers for pineapple-papaya were Tk 12800.00, Tk 16100.00, Tk 9750.00 and Tk 4950.00, respectively.
Whereas these cost figures for pineapple-banana-arum cultivation were Tk 9600.00, Tk 11500.00, Tk 6750.00 and Tk 4400, respectively.

**Cost of insecticides**

Farmers used different kinds of insecticides to protect their pineapple in the field from various insects and pests. Table 2 showed that per hectare cost of insecticides were Tk. 9681.00, Tk. 9392.00, Tk. 16793.00 for sole pineapple, pineapple-papaya, pineapple-banana-arum production, respectively.

**Cost of vitamin**

Farmers used vitamin for ripening of pineapple. Table 2 showed that per hectare cost of vitamin were Tk. 12312.00, Tk. 11500.00, Tk. 12263.00 for sole pineapple, pineapple-papaya, pineapple-banana-arum production, respectively.

**Cost of irrigation**

Irrigation water was very essential for pineapple-banana-arum production. Table 2 showed that cost of irrigation water was Tk. 9600.00 per hectare for pineapple-banana-arum production. It should be noted here that irrigation was not required for sole pineapple and pineapple-papaya cultivation.

**Interest on operating capital**

Interest on operating capital includes variable costs in the production of sole pineapple, pineapple-papaya, pineapple-banana-arum which was calculated for a period of 18 months. Table 2 showed that interest on operating capital for sole pineapple, pineapple-papaya, pineapple-banana-arum were Tk. 17956.00, Tk. 19320.00 and Tk. 20093.00 respectively.

**Land use cost**

Table 2 showed that land use cost per hectare was Tk. 78590.00 for sole pineapple, pineapple-papaya, pineapple-banana-arum cultivation.

**Depreciation on farm implements**

Depreciation on farm implements was estimated at Tk. 7361.00 per ha for sole pineapple production, where it was Tk. 9202.00 and Tk. 7837.00 for pineapple-papaya and pineapple-banana-arum respectively (Table 2).

**Total cost**

Total cost was calculated by adding up total variable costs and total fixed costs. Table 2 showed that per hectare total cost for sole pineapple, pineapple-papaya and pineapple-banana-arum cultivation were Tk. 321555.00, Tk. 341304.00 and Tk. 350076.00, respectively.

**Gross return**

Gross return was estimated by multiplying the total amount of product produced by their respective prevailing market price. Table 2 showed that per hectare gross return from sole pineapple was Tk. 508000.00, whereas it was Tk. 606712.00 and Tk. 586000.00 for pineapple-papaya and pineapple-banana-arum, respectively.

**Gross Margin**

The argument for using the gross margin analysis is that the farmers of Bangladesh are more interested to know their return over variable cost. Table 2 showed that per hectare gross margin of sole pineapple was Tk. 290352.00, whereas it was Tk.372520.00 and Tk.342444.00 for pineapple-papaya and pineapple-banana-arum, respectively.

**Net Return**

Net return is calculated by subtracting gross cost from total return. Table 2 showed that per hectare net return of sole pineapple was estimated at Tk. 186445.00, whereas it was Tk. 265408.00 and Tk. 235924.00 for pineapple-papaya and pineapple-banana-arum respectively.

**Benefit Cost Ratio (Undiscounted)**

The undiscounted benefit cost ratio (BCR) was calculated as a ratio of gross returns and gross costs. Table 2 showed that BCR of sole pineapple production was 1.58, whereas it was 1.78 and 1.67 for pineapple-papaya and pineapple-banana-arum respectively.

**Functional analysis**

Considering the importance of the inputs affecting pineapple production, a number of inputs i.e. seedling, human labor, fertilizer, insecticides, power tiller, vitamin and manure were considered as explanatory variables. The individual effects of these inputs on the gross return can be explained to a certain degree by multiple regression analysis. Findings from a log-linear specification are presented in Table 3.

The estimated Cobb-Douglas production function for sole pineapple was:

\[\ln Y = 4.521 + 0.087 \ln X_1 + 0.422 \ln X_2 + 0.068 \ln X_3 + 0.237 \ln X_4 + 0.065 \ln X_5 - 0.058 \ln X_6 + 0.046 \ln X_7\]

Cobb-Douglas production function for pineapple-papaya was:

\[\ln Y = 5.327 + 0.073 \ln X_1 + 0.520 \ln X_2 + 0.449 \ln X_3 + 0.179 \ln X_5 + 0.056 \ln X_4 - 0.053 \ln X_6 + 0.078 \ln X_7\]

Cobb-Douglas production function for pineapple-banana-arum was:

\[\ln Y = 4.063 + 0.063 \ln X_1 + 0.466 \ln X_2 + 0.039 \ln X_3 + 0.116 \ln X_4 + 0.071 \ln X_5 - 0.046 \ln X_6 + 0.036 \ln X_7\]

**Seed cost**

It is observed from Table 3 that the production coefficient of seed cost were 0.087, 0.073, 0.063 which were positive and significant at 1 percent level. It implies that one percent increase in seed cost, keeping other factors constant, would increase gross returns of sole pineapple, pineapple-papaya and pineapple-nanana-arum by 0.087, 0.073, 0.063 percent respectively.
Relative profitability of pineapple inter-crops

Table 3. Coefficients of Cobb-Douglas production function for sole pineapple, pineapple-papaya and pineapple-banana-arum

| Explanatory variable | Sole Pineapple | Pineapple-papaya | Pineapple-banana-arum |
|----------------------|----------------|------------------|-----------------------|
| Intercept            | 4.521          | 5.327            | 4.063                 |
| Seedling cost        | 0.087***       | 0.073***         | 0.063***              |
| Labour cost          | 0.422**        | 0.520**          | 0.466**               |
| Fertilizer cost      | 0.068          | 0.449            | 0.039                 |
| Insecticides cost    | 0.237**        | 0.179            | 0.116*                |
| Power tiller cost    | 0.065*         | 0.056*           | 0.071                 |
| Vitamin cost         | -0.058         | -0.053           | -0.046                |
| Manure cost          | 0.046***       | 0.078***         | 0.036***              |
| R²                   | 0.641          | 0.773            | 0.685                 |
| F- value             | 19.84***       | 14.79***         | 12.28***              |
| Return to scale      | 0.867          | 1.302            | 0.745                 |

Source: Author’s calculation based on field survey, 2015.
(Figures within parentheses indicate the standard error)
Note: *** Significant at 1 percent level
** Significant at 5 percent level
*Significant at 10 percent level

Human labour cost
The calculated regression coefficient of human labour cost were 0.422, 0.520, 0.466 in sole pineapple, pineapple-papaya, pineapple - banana - arum with a positive sign and were significant at 5 percent level. It implies that one percent increase in human labour cost, keeping other factors constant, would increase gross returns by 0.422, 0.520, 0.466 percent respectively.

Fertilizer cost
The estimated value of the coefficient of fertilizer in sole pineapple, pineapple-papaya, pineapple - banana - arum were 0.068, 0.449, 0.039 which were of positive but statistically insignificant. So it had no significant impact on gross return.

Insecticides cost
The estimated coefficient of insecticides cost of sole pineapple, pineapple - banana - arum were 0.237, 0.116 and significant at 5 and 10 percent level. It implies an increase in one percent of money spent on insecticides cost, keeping other factors constant, increase gross returns by 0.237, 0.116 percent respectively from sole pineapple and pineapple - banana - arum. But the coefficient of pineapple - papaya was positive and statistically insignificant and it had no significant effect on return from pineapple - papaya.

Power tiller cost
The calculated regression coefficient of power tiller cost were 0.065 and 0.056 in sole pineapple and pineapple - papaya with positive sign and significant at 10 percent level. It indicates that an increase in one percent of power tiller cost, remaining other factors constant, would increase gross return 0.065 and 0.056 percent respectively. But the coefficient of pineapple - banana - arum was positive and statistically insignificant and it had no significant effect on return from pineapple - banana - arum.

Vitamin cost
The calculated regression coefficient of vitamin cost were 0.058, 0.053, 0.046 in sole pineapple, pineapple - papaya, pineapple - banana - arum with negative sign and statistically insignificant. It indicates that vitamin cost had no significant impact on gross returns.

Manure cost
The coefficient of manure cost for producing sole pineapple, pineapple-papaya, pineapple - banana - arum were 0.046, 0.078, 0.036 respectively which were positive and significant at 1 percent level. It implies that one percent increase in manure cost, keeping other factors constant, would increase gross returns by 0.046, 0.078, 0.036 percent respectively.

Coefficient of Multiple Determination (R²)
The coefficient of determination (R²) is a summary that tells how well the sample regression line fit with the data (Mitu, 2013). It is evident from Table 3 that the value of the coefficient of multiple determinations (R²) is 0.641, 0.773 and 0.685 for sole pineapple, pineapple-papaya,
pineapple-banana-arum which mean that the explanatory variables included in the model explained 64.1, 77.3 and 68.5 percent of the total variation in gross return from sole pineapple, pineapple-papaya, pineapple-banana-arum production.

F-value
The F-value was estimated for overall significance of the estimated model. The F-value of the model for sole pineapple, pineapple-papaya, pineapple-banana-arum were 19.84, 14.79 and 12.28, respectively which were significant at 1 percent level implying that the variation in gross return depends mainly upon the explanatory variables included in the model.

Returns to scale
In the present study, the sum of the coefficients of all inputs for sole pineapple, pineapple-banana-arum farmers was 0.867, 0.745. This implies that production exhibited decreasing returns to scale (Table 3). The sum of the coefficients of all inputs for pineapple-papaya was 1.302 which implies that production exhibited increasing returns to scale.

Conclusion and Recommendation
From the results of the present study, it can be concluded that considerable scope apparently exists in the study area to increase the productivity of pineapple. Pineapple is an important fruit because of its dietary values and sources of income for the pineapple farmers. Pineapple cultivation is attractive because it is labour intensive fruit crop. It is also considered more profitable and less risky as compared to the production of other fruit crops. This is a very pragmatic study in the context of Bangladesh.

- In order to improve profitability of the pineapple production, measures are essential to reduce the cost of production.
- Operating capital is a problem for the resource poor farmers of the study area. Without institutional credit support, it is difficult for the small farmers to cultivate pineapple in large area. It is, therefore, necessary that credit with easy terms should be provided to the farmers for the entire area under pineapple.
- So, Government and non-government research institutions should strengthen their human resources for pineapple production.

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### Appendix 1. Total cost and return per hectare for sole pineapple production

| Items                  | Unit  | Quantity | Price per unit (Tk.) | Total value (Tk.) | Percentage |
|------------------------|-------|----------|----------------------|-------------------|------------|
| A. Gross return        |       |          |                      |                   |            |
| Pineapple              | Pieces| 31750    | 16.00                | 508000.00         | 100.00     |
| Total Return           |       |          |                      | 508000.00         | 100.00     |
| B. Gross cost          |       |          |                      |                   |            |
| Variable costs         |       |          |                      |                   |            |
| Human Labour           | Man-days |        |                      |                   |            |
| Land preparation       |       | 50       | 350.00               | 17500.00          | 5.44       |
| Planting, fertilizer application |       | 73       | 350.00               | 25550.00          | 7.94       |
| Weeding                |       | 42       | 350.00               | 14700.00          | 4.57       |
| Harvesting and carrying|       | 53       | 350.00               | 18550.00          | 5.57       |
| Total                  |       | 218      | 350.00               | 76300.00          | 23.72      |
| Power tiller           |       |          |                      | 7700.00           | 2.39       |
| Seeding                | Pieces| 31850    | 2.00                 | 63700.00          | 19.80      |
| Manure: Cow-dung       | Kg    | 3803     | 1.50                 | 5705.00           | 1.77       |
| Fertilizer: Urea       | kg    | 800      | 16.00                | 12800.00          | 3.98       |
| TSP                    | kg    | 650      | 23.00                | 14950.00          | 4.64       |
| MP                     | kg    | 600      | 15.00                | 9000.00           | 2.79       |
| Gypsum                 | kg    | 500      | 11.00                | 5500.00           | 1.71       |
| Total                  |       | 29718    |                      | 42250.00          | 13.13      |
| Insecticides           |       |          |                      | 9661.00           | 3.01       |
| Vitamin                |       |          |                      | 12312.00          | 3.82       |
| Total variable cost    |       |          |                      | 217648.00         |            |
| Fixed Costs            |       |          |                      |                   |            |
| Interest on operating capital |       |          |                      | 17956.00          | 5.58       |
| Land use cost          |       |          |                      | 78590.00          | 24.44      |
| Depreciation on farm implements |   |          |                      | 7361.00           | 2.29       |
| Total Fixed Cost       |       |          |                      | 103907.00         |            |
| Total cost             |       |          |                      | 321555.00         | 100.00     |
| C. Gross margin (GR-TV C) |   |          |                      | 290352.00         |            |
| D. Net return (NR)=(GR-TC) | |          |                      | 186445.00         |            |
| E. Benefit cost ratio (GR/TC) | |          |                      | 1.58              |            |

Source: Field survey, 2015.

### Appendix 2. Total cost and return per hectare for of pineapple-papaya production

| Items                  | Unit  | Quantity | Price per unit (Tk.) | Total value (Tk.) | Percentage |
|------------------------|-------|----------|----------------------|-------------------|------------|
| A. Gross return        |       |          |                      |                   |            |
| Pineapple              | Pieces| 30400    | 16.00                | 486400.00         | 80.16      |
| Papaya                 | Kg    | 10026    | 12.00                | 120312.00         | 19.83      |
| Total Return           |       |          |                      | **606712.00**     | 100.00     |
| B. Gross cost          |       |          |                      |                   |            |
| Variable costs         |       |          |                      |                   |            |
| Human Labour           | Man-days |        |                      |                   |            |
| Land preparation       |       | 60       | 350.00               | 21000.00          | 6.15       |
| Planting, fertilizer application |       | 80       | 350.00               | 28000.00          | 8.20       |
| Weeding                |       | 45       | 350.00               | 15750.00          | 4.61       |
| Harvesting and carrying|       | 65       | 350.00               | 22750.00          | 6.66       |
| Total                  |       | 250      | 350.00               | 87500.00          | 25.63      |
| Power tiller           |       |          |                      | 9500.00           | 2.78       |
| Seeding of pineapple   | Pieces| 30600    | 2.00                 | 61200.00          | 17.93      |
| Seeding of papaya      | Pieces| 1500     | 2.00                 | 3000.00           | 0.88       |
| Manure: Cow-dung       | Kg    | 5667     | 1.50                 | 8500.00           | 2.49       |
| Fertilizer: Urea       | kg    | 800      | 16.00                | 12800.00          | 3.75       |
| TSP                    | kg    | 700      | 23.00                | 16100.00          | 4.71       |
| MP                     | kg    | 650      | 15.00                | 9750.00           | 2.85       |
| Gypsum                 | kg    | 450      | 11.00                | 4950.00           | 1.45       |
| Total                  |       | 43600    |                      | 12.77             |            |
| Insecticides           |       |          |                      | 9392.00           | 2.75       |
| Vitamin                |       |          |                      | 11500.00          | 3.37       |
| Total variable Cost    |       |          |                      | **234192.00**     |            |
| Fixed Costs            |       |          |                      |                   |            |
| Interest on operating capital |   |          |                      | 19320.00          | 5.66       |
| Land use cost          |       |          |                      | 78590.00          | 23.02      |
| Depreciation on farm implements |   |          |                      | 9202.00           | 2.70       |
| Total Fixed Cost       |       |          |                      | **107112.00**     |            |
| Total cost             |       |          |                      | **341304.00**     | 100.00     |
| C. Gross margin (GR-TV C) |   |          |                      | **372520.00**     |            |
| D. Net return (NR)=(GR-TC) | |          |                      | **265408.00**     |            |
| E. Benefit cost ratio (GR/TC) | |          |                      | **1.78**          |            |

Source: Field survey, 2015.
Appendix 3. Total cost and return per hectare for of pineapple-banana-arum production

| Items                        | Unit       | Quantity | Price per unit (Tk.) | Total value (Tk.) | Percentage |
|------------------------------|------------|----------|----------------------|-------------------|------------|
| A. Gross return              |            |          |                      |                   |            |
| Main product                 | pieces     | 29500    | 16.00                | 472000.0          | 80.55      |
| Banana                      | bunch      | 370      | 200.00               | 74000.0           | 12.62      |
| Arum                        | kg         | 2000     | 20.00                | 40000.0           | 6.82       |
| Total Return                 |            |          |                      | 586000.00         | 100.00     |
| B. Gross cost                |            |          |                      |                   |            |
| Variable Costs               |            |          |                      |                   |            |
| Human Labour:                | Man-days   |          |                      |                   |            |
| Land preparation             |            | 65       | 350.00               | 22750.0           | 6.49       |
| Planting, fertilizer application |     | 90       | 350.00               | 31500.0           | 8.99       |
| Weeding                      |            | 50       | 350.00               | 17500.0           | 4.99       |
| Harvesting and carrying      |            | 70       | 350.00               | 24500.0           | 6.99       |
| Total                        |            | 275      | 350                  | 96250.0           | 27.49      |
| Power tiller                 |            |          |                      | 9800.0            | 2.79       |
| Seedling of pineapple        | pieces     | 29750    | 2.00                 | 59500.0           | 16.99      |
| Sucker of banana             | pieces     | 400      | 2.50                 | 1000.0            | 0.28       |
| Seeds of arum                | pieces     | 600      | 1.00                 | 600.0             | 0.17       |
| Manure: Cow-dung             | kg         | 3667     | 1.5                  | 5500.0            | 1.57       |
| Fertilizer: Urea             | kg         | 600      | 16.00                | 9600.0            | 2.74       |
| TSP                          | kg         | 500      | 23.00                | 11500.0           | 3.28       |
| MP                           | kg         | 450      | 15.00                | 6750.0            | 1.92       |
| Gypsum                       | kg         | 400      | 11.00                | 4400.0            | 1.25       |
| Total                        |            | 32250    | 9.21                 |                   |            |
| Insecticides                 |            |          |                      | 16793.0           | 4.79       |
| Vitamin                      |            |          |                      | 12263.0           | 3.50       |
| Irrigation                   |            |          |                      | 9600.0            | 2.74       |
| Total variable cost          |            |          |                      | 243556.00         |            |
| Fixed Costs                  |            |          |                      |                   |            |
| Interest on operating capital|            |          |                      | 20093.0           | 5.74       |
| Land use cost                |            |          |                      | 78590.0           | 22.44      |
| Depreciation on farm implements |        |          |                      | 7837.0            | 2.24       |
| Total Fixed Cost             |            |          |                      | 106520.0          |            |
| Total Cost                   |            |          |                      | 350076.00         | 100.00     |
| C. Gross margin (GR-VC)      |            |          |                      | 342444.00         |            |
| D. Net return (NR)=(GR-TC)   |            |          |                      | 235924.00         |            |
| E. Benefit cost ratio (GR/TC)|            |          |                      | 1.67              |            |

Source: Field survey, 2015.