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Profitability Analysis of Different Agroforesty Practices in Tangail District

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ABSTRACT

The present study was carried out on jackfruit-pineapple and Akashmoni-Pineapple agroforestry system with association of aroid and ginger at Madhupur upazilla under Tangail district. Primary data were collected from 120 farmers from four villages under Madhupur upazilla of Tangail district. The study was conducted during the period from April to September, 2012 through interview schedule. The net return from Akashmoni-Pineapple-Ginger agroforestry system was higher than other agroforestry system. Compounding, the net return from Akashmoni-Pineapple-Ginger agroforestry system was also higher than other agroforestry system. The net return from Jackfruit-Pineapple-Aroid agroforestry systems was higher than Akashmoni-Pineapple-aroid agroforestry system before compounding but it was lower after compounding. Inter temporal budget for Jackfruit- Pineapple- Aroid agroforestry production system for 20 years explained that the cash flow in the 1st year was negative but it became positive from second year and it continued in subsequent years. Benefit cost ratio (BCR) of Jackfruit–Pineapple-Aroid production for 20 year at 12% discounted rate was 1.02 and NPVat 12% discounted rate was Tk. 49516.7per hectare. Sensibility Analysis shows that Jackfruit- Pineapple- Aroid agroforestry system for 20 years was sensible to increment and reduction of cost and gross returns. A good number of problems for different agroforestry system were identified.

Key words: Agroforsty, Akashmoni, Compounding, Discount, Sensibility

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1. INTRODUCTION

Agroforestry is an idea of combining forestry and agriculture on the same piece of land. The basic concept of intercropping has been extended to agroforestry systems. Many authors have defined agroforestry in different ways. A widely used definition given by the International Council for Research in Agroforestry (ICRAF) is that "Agroforestry is a collective name for all land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc) are deliberately used on the same land management units as agricultural crops and/or animals in some form of spatial

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arrangement or temporal sequence" (ICRAF, 2003). Agroforestry is a century old livelihood production systems in most of the ecosystems, particularly floodplain, hill and terrace ecosystems of Bangladesh.Homestead is a low cost production system, which can contribute significantly to the house hold economy and food security. The homestead owners themselves consume a large proportion of the products of homesteads and the rest of the products are sold in the market. The amount of income derived from homesteads is primarily determined by crop composition in the garden although livestock, poultry and fish ponds also contribute a lot. Income derived from homestead range from 0.8 to 54 percent of family's total income (Abdullah et al*.,* 1983).

The agroforestry system whether it is in homestead or in cropland, thus presents an excellent multipurpose land-use system. Although agroforestry systems prevail all over the country, a unique pattern of agroforestry systems has been developed at Madhupurupazilla under Tangail district especially in the homestead and adjoining areas due to topography andclimatic advantages.Madhupur is located at 24.6167°N and 90.0250°E . It has 74984 units of house hold and total area 500.67 km².It has a large forest area named 'MadhupurerGor". Madhupur is famous throughout the country for delicious pineapples. The agroforestry systems in this region are so developed that it is very hard to find sole cropping system except the valleys. Pineapple is the most common fruit are cultivated in this region and various trees are grown in association with pineapple such as mahogany, jackfruit, shal, date palm, eucalyptus, akashmoni, etc. among them Jackfruit and Akashmoni based agroforestry practices are mostly common used practices in madhupurupazilla. As a result a unique pattern of pineapple based agroforestry systems has been developed at madhupurupazilla. Some important cash generating vegetables such as turmeric, ginger and aroid are also extensively grown in association with pineapple in those agroforestry at Madhupur to maximize the use of land. Agroforestry system not only provides farmers with an effective land use management system but also can ensure more production in a balanced ecological environment. In this system, farmers believe that the partial shade of the trees improves the physical environment for pineapple that ultimately enhances the yield and quality of the latter and soil quality and also generate the income. Bangladesh has poor forest resources which is decreasing day-by-day due to several reasons. This serious depletion of forest resources is due to rapid population growth rate 1.33 percent (BBS, 2010). Furthermore, the land hungry agricultural sector is converting forest land to agricultural uses to feed the burgeoning population of Bangladesh. Due to this deforestation, serious imbalances have already been created in the eco-systems.

In the practice of agroforestry systems, these elements or dimensions are influential towards the attitude and orientation of rural farmers, and as such, an understanding of local culture with indigenous knowledge systems and practices is often emphasized for successful agroforestry interventions (Rusten & Gold, 1995; Warren et al., 1995; Anacleti, 2002). While much agroforestry research has addressed biological complexities associated with agroforestry systems, less emphasis is given to social aspects, which can in turn impact all spheres of agroforestry practices (Nair, 1998; Rule et al., 2000). (Rule et al., 2000) suggests, "For agroforestry to be successful – to be adopted and diffused throughout a social system – it will require an understanding of the social dimensions. Unless the social setting in which these practices or technologies are to be implemented is understood, technology transfer will be constrained." For instance, (Puri & Nair, 2004) note that though significant efforts have been given to promote and implement agroforestry practices in India, modern agroforestry technologies have not been widely accepted by the farmers possibly because the 'scientific principles' behind successful indigenous agroforestry systems have not been studied well. Social relations and networks play important roles in farming communities. A study of a farmer-led agroforestry extension project in the villages of Western Kenya showed that dissemination of seed and knowledge within and between the villages was dependent on informal social networks, that is, the kinship ties of the farmers with their relatives, groups, neighbors and friends (Kiptot et al., 2006). Also, in a study on an extension project in Mexico, it was found that farmers trust their informal relationship with neighbors, friends to collect or exchange seeds more than any other source, whereas in Zimbabwe the situation was quite opposite where observing others' fields and learning from others are assumed to be witchcraft (Meinzen-Dick & Adato, 2007).

The human civilization initiated with the cultivation of crops by the ancient humans close or nearby their inhabitancy in the forest. It was agroforestry. At this state of advanced civilization, the modem people are going back to agroforestry with the principle of growing trees in all possible places including homesteads and crop field. In both the cases, there is an association of trees with other food/ feed producing plants and/or useful animals which constitute the fundamental principle of agroforestry (Haque,1996). However, due to lack of modem knowledge, the potential benefits of agroforestry are still remaining entrapped. To take the full advantage of perceived potentials, there is an urgent need to identify and strengthen efforts to develop sustainable agroforestry production and utilization systems for maximizing production and income by knowing the existing opportunities and limitation, and scope for future improvement. Agroforestry system, more particularly, tree-pineapple in association with vegetables system may be popular among the farmers if some positive steps are taken for improving its production and different management practices. Before giving any policy options on the development of tree-pineapple in association with vegetables system as well as increasing fruit, vegetable and pineapple as well as timber production, relevant and adequate information on various aspects of the system at farm level is required.

But such information is very limited due to lack of adequate research in the field. Different researchers (Aktar et al., 1989; Singh et al., 2001; Abedin et al., 1990) also suggested detailed studies in the existing agroforestry systems.Therefore, the present study was undertaken in view of the above discussion to collect the information for satisfying the following objectives: a) Identification of agroforestry system b) Profitability analysis of different agroforestry practice.

2. METHODOLOGY

Population and Sampling Technique

There were 860 household in the study area. Among them 250 household were selected following purposive sampling technique where farm size was considered as strata. The study was conducted during the period from April to September, 2012 through interview schedule, direct interviewing of the respondents, field visit and observations, and discussion with the concerned experienced farmers.

Analytical Techniques

Benefit cost ratio (BCR)

To assess the profitability level of different agroforestry practices, grower's simple tabular form and benefit cost ratio (BCR) was checked. BCR of different agroforestry practices was estimated by the ratio of gross return to variable cost and gross return to total cost. It is also defined as the difference between the value of goods and service produced by a farm and cost of resource used in production. The undiscounted BCR was worked out using the following formula. Where

$$\text{BCR} = \frac{\text{Total return}}{\text{Total cost}}$$

Law of compounding

A formula for calculating compounding value of diferent agroforestry practice is

$$S = P\left(1 + \frac{j}{m}\right)^{mt}$$

Where,
S = value after t periods
t = number of years for calculating compounding value
P = principal amount (initial value)
j = annual nominal interest rate (not reflecting the compounding)
m = number of times the interest is compounded per year

Net present value (NPV)

This is the present value of cash flow stream. It can be computed by subtracting the total present value of cost from the total present value of benefit.

$$\text{Net Present Value (NPV)} = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t}$$

Where,
B_t = Gross benefit in i^{th} year
C_t = Total cost in i^{th} year
t = Number of year (1, 2, 3, 4…….n)
i = Interest (discount) rate (assuming 0.12).

3. RESULTS AND DISCUSSION

Identification of Agroforestry System

Agroforestry system practiced by the farmers in homestead and adjoining areas were identified through formal survey technique method. A total of 200 major and minor traditional and new agroforestry systems were identified in the study areas, however, the top ranked ten agroforestry systems are presented in Table 1.

The Table 1 shows that the main tree species were jackfruit and Akashmoni. The associated crops grown in association with tree species varied widely. The major crop species was pineapple associated with main tree species. The most common vegetable and spices under pineapple garden was aroid followed by ginger, turmeric. However in most of the cases three distinct layers in agroforestry systems were found. The top layer represented by tree species such as jackfruit, akashmoni, eucacalyptus, mehagoni etc. followed by pineapple and some vegetable or spices like aroid , ginger, turmeric etc. Detail information on agronomic and economic aspects of the three top most agroforestry practices was investigated from the identified traditional and new agroforestry system.

Profitability Analysis of Different Agroforestry Practice

Benefit Cost Ratio (BCR)

Benefit cost ratio was estimated as the highest 1.44 incase of Akashmoni- Pineapple-ginger system followed by 1.27 for Jackfruit - Pineapple-Aroid practice and 1.22 for Akashmoni-Pineapple-Aroid practice (Table 2).

Yield and Gross Return (GR) from Tree Species

The number of Akashmoni tree was the highest 299 incase of Akashmoni-Pineapple-Aroid practice followed by 285for Akashmoni- Pineapple-Ginger practice. The number of jackfruit tree was 95 incase of Jackfruit-Pineapple-Aroid system. (Table 3). The price of 10 years aged Akashmoni tree was as average 4500 Tk. and the price of Jackfruit tree was 3500 Tk. (approximately).

Table 3 also shows that per hectare total return from tree log was the highest for Akashmoni tree incase of Akashmoni- Pineapple-Aroid practice Tk. 1348700 followed by Akashmoni- Pineapple-Ginger practice Tk. 1285800 for Akashmoni tree and incase of Jackfruit-Pineapple-Aroid practice Tk. 333790 for Jackfruit tree.

Cost, Return, Gross Margin and BCR after Compounding for 10 Years

In agroforesty system trees are most important component.But in the calculation of cost, return, gross margin and BCR of the diferent agroforestry system, tree component was neglegile because of the product of tree were not mesurable before the maturity of the tree. Akashmoni and Jackfruit tree take at lest 5-10 year to produce economic valuable log of those tree. So the return from tree components were calculated in the 10 years aged log of the

Table 1. The top ranked ten agroforestry systems in Bangladesh.

Sl. No.	Different types of agro forestry practices	No. of respondents	Percentage (%)	Ranking
1	Akashmoni +Pineapple + Aroid	54	21.6	First
2	Akashmoni +Pineapple + Ginger	48	19.2	Second
3	Jackfruit + Pineapple+ Aroid	35	14	Third
4	Akashmoni +Pineapple	25	10	Fourth
5	Jackfruit+ Pineapple	23	9.2	Fifth
6	Eucalyptus + Pineapple	20	8	Sixth
7	Mehagony + Pineapple	20	8	Seventh
8	Jackfruit + Pineapple+ Ginger	10	4	Eighth
9	Jackfruit +Pineapple+ Turmeric	08	3.2	Ninth
10	Akashmoni +Pineapple + Turmeric	07	2.8	Tenth
	Total	250	100	

Table 2. Per hectare cost, return, gross margin and BCR of diferent agroforestry practice.

Cost & Return per hectare	Name of the system					
	Akashmoni-Pineapple-Aroid		Akashmoni-Pineapple-Ginger		Jackfruit-Pineapple-Aroid	
	Mean	SE	Mean	SE	Mean	SE
Total Cost (Taka)	481160	11877	482286.8	5959	539080	45325
Total Return (Taka)	589930	13510	695801.2	10579	688250	66306
Gross margin(Taka)	108770	8195	213514.1	9372	149170	37103
BCR	1.22	0.01	1.44	0.02	1.27	0.07

Table 3. Per hectare log and return of trees of diferent agroforestry practice after 10 year (aproximately).

Return per hectare	Name of the system					
	Akashmoni-Pineapple-Aroid		Akashmoni-Pineapple-Ginger		Jackfruit-Pineapple-Aroid	
	Mean	SE	Mean	SE	Mean	SE
Tree (No.)	299	13.1	285	16.4	95	4.32
Return (Taka)	1348700	59061	1285800	73615	333790	15135

Table 4. Per hectare cost, return, gross margin and BCR of diferent agroforestry practice after compounding for 10 years.

Cost, Return & Gross margin per hectare	Name of the system					
	Akashmoni-Pineapple-Aroid		Akashmoni-Pineapple-Ginger		Jackfruit-Pineapple-Aroid	
	Mean	SE	Mean	SE	Mean	SE
Total Cost (Taka)	1494000	36879	1497500	18504.3	1673800	140734
Total Return (Taka)	1831700	41950	2160500	32850	2137000	205881
Gross margin(Taka)	337720	25445	662960	29102	463180	115207
BCR	1.22	0.01	1.44	0.02	1.28	0.07

tree (aproximately). For this reason compounding of cost, return, gross margin of other components of different agroforesty system for 10 years was necessary to include the product of tree species in calculation. After compounding the result are discussed bellow:

The total cost and return from Akashmoni- Pineapple-Ginger agroforestry system was Tk. 1497500/ha and Tk. 3446300/ha, respectively, and the net return was Tk. 1948800/ha. The benefit cost ratio derived as 2.30 (Table 5).

The total cost and return from Jackfruit-Pineapple-Aroid agroforestry system was Tk. 1673800/ha and Tk. 2470790 /ha, respectively, and the net return was Tk. 796990/ha. The benefit cost ratio derived as 1.47**.** (Table 5)

The total cost and return from Akashmoni-Pineapple-Aroid agroforestry system was Tk. 1494000/ha and Tk. 3180400/ha, respectively, and the net return was Tk. 1686400/ha. The benefit cost ratio derived as 2.12 (Table 5).

Table 5. Data adjustment between the per hectare cost, return, gross margin and BCR of diferent agroforestry practice after compounding for 10 years and per hectare cost, return, gross margin and BCR of tree species.

Cost, Return & Gross margin per hectare	Name of the system					
	Akashmoni-Pineapple-Aroid		Akashmoni-Pineapple-Ginger		Jackfruit-Pineapple-Aroid	
	Mean	SE	Mean	SE	Mean	SE
Total Cost (Taka)	1494000	36879.7	1497500	18504.3	1673800	140734
Total Return (Taka)	3180400	101011	3446300	106465	2470790	221016
Gross margin(Taka)	1686400	64131	1948800	87960	796990	80282
BCR	2.12	0.01	2.30	0.02	1.47	0.07

Table 6. Benefit cost ratio of jackfruit–pineapple-aroid production for 20 year.

Age of orchard (year)	Gross cost (Taka)	Gross return (Taka)	Cash flow (CF) Taka)	Discounted Gross cost at 12% DR(Taka)	Discounted Gross return at 12% DR(Taka)	Net present value at 12%DR (Taka)
1	957420	96856	-860564	854839	86479	-768360.7
2	402760	509720	106960	321078	406346	85267.9
3	144720	170420	25700	103009	121302	18292.8
4	190520	508870	318350	121079	323396	202317.2
5	243800	250020	6220	138339	141868	3529.4
6	288250	347830	59580	146036	176222	30185.1
7	152030	155180	3150	68771	70196	1424.9
8	191140	504270	313130	77198	203666	126468.0
9	342290	352230	9940	123433	127018	3584.5
10	188910	424940	236030	60824	136819	75995.3
11	159280	228730	69450	45789	65754	19965.2
12	192220	504160	311940	49338	129405	80067.2
13	346390	397980	51590	79384	91207	11823.1
14	190680	388150	197470	39017	79423	40406.3
15	155840	164370	8530	28471	30030	1558.4
16	195230	513920	318690	31846	83831	51985.2
17	349230	351970	2740	50863	51262	399.1
18	195700	411670	215970	25449	53533	28084.7
19	161970	188490	26520	18806	21885	3079.2
20	200110	522720	322610	20745	54189	33443.9
Total				2404314	2453831	49516.7

PV= present value, DR= discounted rate

Table 7 Sensitivity analysis of the jackfruit-pineapple orchard.

Sensitivity analysis considering	Benefit Cost Ratio	Net Present Value(Taka)
(i) Cost increased by 10 percent	0.93	-270865
(ii) Gross return reduced by 10 percent	0.92	-195867
(ii) Gross return increased by 10 percent	1.12	294899
(iii) Cost increased by 10 percent and gross return reduced by 10 percent	0.84	-436298

Inter temporal Budgeting for Jackfruit –Pineapple-Aroid Agroforestry System

Inter temporal budget for Jackfruit- Pineapple- Aroid agroforestry production system showed that the cash flow in the 1st year was negative but it became positive from second year and it continued in subsequent years. Each cash flow varied from year to year and it depends on the season of crops because the cost and return varied within this time. Inter temporal budgeting for Jackfruit- Pineapple- Aroid agroforestry system is presented in Table 6 For inter temporal budgeting all costs incurred and benefit was

accrued from the trees has been taken into consideration.

Costs

For the calculation of the cost of Jackfruit- Pineapple- Aroid agroforestry system, farmers' assumption had been considered. Questionnaire was supplied to respondents to calculate the cost of orchard of Jackfruit- Pineapple- Aroid agroforestry system which was established with all initial cost. During initial stage cost was very high due to inputs .On the other hand pineapple became harvestable at the age of 4 and2 years, respectively and after each 4 year orchard of Pineapple was established newly. So inputs cost after each 4 year was very high. Aroid became harvestable at the age of 2 years and after each 4 year orchard of Pineapple was established newly. So inputs cost after each 4 year was also high. In this way cash flow varied year to year. Initial cost incurred for Jackfruit and pineapple plantation included saplings, suckers, bamboo stick, and fertilizers.

Benefits

Benefits from Jackfruit- Pineapple- Aroid agroforestry system started from second year of planting. Pineapple became harvestable at the age of 4 and2 years, respectively. So benefits each 2 and 4 year were high. Aroid became harvestable at the age of 2 years. So benefits each 2 year were also high. The log of jackfruit tree were considered to harvest in the season of establishing new orchard to meet up the extra cost of establishing new orchard within jackfruit–pineapple-aroid production time for 20 year.

Benefit cost ratio (BCR) of jackfruit–pineapple-aroid production for 20 year at 12percent discounted rate was 1.02 and Net Present Value (NPV) at 12percent was Tk.49516.7 per hectare BCR at 12percent discounted rate (1.02) indicate that, if farmers' invest 100 Tk, he would get 102 Tk. Accord with similar investigation on other research Kibria & Shah (2011) found Net Present Value (NPV) banana agroforestry is financially more profitable than other two systems, while the Benefit-Cost ratio (BCR) is higher in pineapple agroforestry (4.21 in participatory agroforestry and 3.35 in privately managed land). Even though banana agroforestry gives higher NPV, capital required for this practice is much higher. The findings suggest that pineapple agroforestry has a tendency towards becoming ecologically and economically more sound than other two practices as it has better ecological attributes and required comparatively low investment.

Sensitivity Analysis

Sensitivity analysis of the jackfruit-pineapple agroforestry system for 20 years **(**Table 7**)** were done considering

- Cost increased by 10 percent,
- Gross return reduced by 10 percent and
- Cost increased by 10 percent and gross return reduced by 10 percent.

Sensibility Analysis showed that, when Cost increased by 10 percent, the BCR Net Present Value were 0.93 and TK. -270865, respectively. When Gross return reduced by 10 percent the BCR and Net Present Value were 0.92 and TK. -195867, respectively. When Gross return increased by 10 percent the BCR and Net Present Value were 1.12 and TK. 294899, respectively. When Cost increased by 10 percent considering the gross return reduced by 10 percent the BCR and Net Present Value was 0.84 and TK. - 436298, respectively. Sensibility Analysis shows that Jackfruit-Pineapple- Aroid agroforestry system is sensible to increment and reduction of cost and gross returns. Cost increased by 10 percent, Gross return reduced by 10 percent, Cost increased by 10 percent and gross return reduced by 10 percent lead the production practice to remain loss. On the other hand Gross return increased by 10 percent lead the production practice to remain profit.

4. CONCLUSION

- Ten top-ranked agroforestry systems were identified in the study area. Three top-ranked systems were taken into detail study on economic and social aspects. The top-ranked three agroforestry systems were Akashmoni- Pineapple- ginger practice, Akashmoni-Pineapple-Aroid practice and Jackfruit-Pineapple-Aroid practice.
- The net return from Akashmoni-Pineapple-Ginger agroforestry system was higher than other agroforestry system in both cases before and after compounding.
- **T**he net return from Jackfruit-Pineapple-Aroid agroforestry systems was higher than Akashmoni-Pineapple-Aroid agroforestry system before compounding but lower after compounding.
- Inter temporal budget for Jackfruit- Pineapple-Aroid agroforestry production system showed that the cash flow in the 1st year was negative but it became positive from second year and it continued in subsequent years.

Sensibility Analysis shows that Jackfruit- Pineapple- Aroid agro forestry system was sensible to increment and reduction of cost and gross returns.

5. RECOMENDATIONS

On the basis of the findings of the study and their logical interpretation, the following recommendations were made:

- Farmers and extension workers should be trained on improved management practices (fertilization, application of hormone etc.) to improve the productivity of different agroforestry practices.
- A sound marketing system should be developed. Besides, necessary processing plant should be established to prevent spoilage of fruits at the time of peak harvest.

- Appropriate research program should be undertaken to develop effective control measures against the jackfruit borer.
- Steps should be taken to replace the local cultivar of pineapple with improved cultivar to increase productivity and profitability of the system.

Such study should also be conducted at the other Pineapple based agroforestry dominant area of the Bangladesh, in order to generalize findings of this study for greater application.

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