Socio-Economic Impact of using Preservative Bamboo Materials in Betel Leaf Farms: An Empirical Study on North-West Region of Bangladesh

M. A. Taher Hossain[1], Khurshid Akhter[1], Evana Nusrat Dooty[2], Rukshana Akther[1] and Forjana Yasmin[1]

[1] *Bangladesh Forest Research Institute, Chittagong, Bangladesh.*

[2] *International Islamic University Chittagong, Bangladesh.*

Email: taherhossain971@ yahoo.com

Abstract

The study was initiated to evaluate economic impact of the treated and untreated bamboo materials using in betel leaf farms. A large number of bamboo culms were consumed because of frequently replacement of bamboo materials in betel leaf farms. Due to growing population and rising demand for bamboo materials, these resources were in decreasing day to day. For preserving bamboo materials into treated form that were needed only 35% to 40% additional cost of its' existing market price. The usable durability of these treated form of thickness basis bamboo materials would be increased and stand for at least 2 to 5 years. A notable number of 1127 ha^{-1} (64%) bamboo culms were being saved per year in the study areas because of treated technology adaptation. The mean IRR, B-C ratio and PVNB were determined to be 40%, 1.21 and Tk.12.1 lakh ha^{-1} for treated farms and 19%, 1.04 and Tk. 3.2 lakh ha^{-1} respectively for untreated ones. If the treated materials are able to be disseminated and covered in betel leaf farms of the country, a significant number of 1.44 crore bamboo culms will be saved. Therefore, using treated bamboo materials in betel leaf farms were economically viable and environmentally most desirable.

সারসংক্ষেপ

এ সমীক্ষায় সনাতনী ও সংরক্ষণী বাঁশের সামগ্রী ব্যবহারে নির্মীত পান বরজের অর্থনৈতিক প্রভাব মূল্যায়ন করা হয়। সাধারণত বরজের বাঁশ সামগ্রী ঘন ঘন প্রতিস্থাপনের কারণে এ শিল্পে প্রচুর পরিমাণে বাঁশসম্পদের প্রয়োজন হয়। ক্রমবর্ধমান জনসংখ্যা ও বাঁশ সামগ্রীর চাহিদা বৃদ্ধির কারণে এ সম্পদ প্রতিনিয়ত হ্রাস পাচ্ছে। বাঁশ সামগ্রী সংরক্ষণে সংরক্ষণী পদ্ধতির জন্য সনাতনী বাঁশ সামগ্রীর বাজার মূল্যের সাথে শতকরা ৩৫ থেকে ৪০ ভাগ অতিরিক্ত ব্যয় সংযোজন করে উক্ত সামগ্রীর পুরুত্ব বেধে ব্যবহারযোগ্য সময়কাল কমপক্ষে ২ থেকে ৫ বছর পর্যন্ত দীর্ঘতর করা হয়। এ সংরক্ষণী পদ্ধতি অনুশীলনের ফলে সনাতনী পদ্ধতির তুলনায় বছরে হেক্টর প্রতি পান বরজে ১১২৭ টি (৬৪%) বাঁশের চাহিদা হ্রাস পায়। যার ফলশ্রুতিতে এ দুই পদ্ধতির পান বরজের তুলনামূলক বিশ্লেষণের অর্থনৈতিক সূচকে দেখা যায় যে, সমীক্ষাকৃত এলাকার গড়মান হিসাবে অভ্যন্তরীন আয় মাত্রা (IRR), আয়-ব্যয় অনুপাত (B-C ratio), এবং প্রতি হেক্টরে নীট লাভ (PVNB) সংরক্ষণী বরজে যথাক্রমে ৪০%, ১.২১ ও টাকা ১২.১ লক্ষ এবং সনাতনী বরজে এ মান ১৯%, ১.০৪ ও টাকা ৩.২ লক্ষ মাত্র। ব্যবহার চলমান সংরক্ষণ প্রক্রিয়ার বাঁশ সামগ্রী সার্বিকভাবে বিদ্যমান পান শিল্পের খামার নির্মাণ খাতে যদি সম্প্রসারণের ব্যবস্থা গ্রহণ করা যায় তবে প্রতিবছর ১.৪৪ কোটি সংখ্যক বাঁশ সম্পদ সাশ্রয় করা সম্ভব হবে। অতএব, পান শিল্পের সনাতনী ও সংরক্ষনী উভয় পদ্ধতির খামারের অর্থনৈতিক প্রভাব বিশ্লেষণে দেখা যায় যে, সংরক্ষনী বাঁশ সামগ্রী দ্বারা তৈরি পান বরজের সক্ষমতা অর্থনৈতিকভাবে যেমন উৎসাহব্যঞ্জক তেমনি পরিবেশগতভাবেও অধিক সুবিধাজনক।

Keywords: Bamboo culms; untreated & treated bamboo materials; betel leaf farm; betel vine; betel leaf; economic parameters

Introduction

The leaves of betel vine are popularly known as *Paan* in Bangladesh. The scientific name of betel vine is *Piper betle* L. The betel leaf farms are locally called "Paan boroj". Two factors are responsible for expansion of the betel leaf farming. First, the global dispersion of the betel leaf chewing in South Asian countries and second, scientific recognition for the medicinal value of betel leaves (Guha, 2006). Betel leaves are one of important cash crop of the country. At present, this crop has a world-wide market. Bangladesh exports this product to the

countries like Pakistan, Dubai, Saudi Arabia, England and some other countries of African continent. But yet, in competition with India and other betel leaf yielding countries, Bangladesh is still has a very little share of the world betel leaves market. (Fatmi et al, 2006). The leaves of betel vine betel are become ready for plucking reportedly found after six months of planting. Cultivators think that a Boroj may be termed as a household bank since the betel leaves can be plucked and sold straight in the market as and when hard cash is required and this may continue for 10 to 30 years or so. The cultivated area under the crop in Bangladesh is about 14,175 hectares and total annual production is about 72,500 tons (Islam, S. 2003). The leaves is matured within 15 to 30 days (Guha, 2006), therefore, 1 to 4 times harvesting are normally done every month.

The management and production of betel leaves is labor intensive. It is from the field ovservation estimated that a part of total population about 5 million people derive their livelihood directly or indirectly, partly or fully from production, processing, handling, transportation and marketing of the betel leaves in the country. The betel vine is raised by vegetative propagation from the cutting under partially shaded and humid environment inside the Boroj, which is a hut like structure of 2 meter in height and from 0.04 to 0.132 ha in area. It is constructed with the local materials like length and thickness basis splitting bamboo sticks, jute sticks, rice straw, etc. wherein the vines are grown on elevated beds imitating the natural ecological conditions suitable to the crop. Among the local materials of consuming capital items, bamboo resources are the most important factors due to its multidimensional use like in making farm structure, housing material and in other sectors of bamboo products. It is assumed that bamboo materials are used in more than 90% of total betel leaf farms of the country. A large number of bamboo culms are being used in betel leaf farming sector. The mostly used bamboo species are *Bambusa valgaris* (baijjha), *Bambusa nutans* (makla), *Babusa balcooa* (borak) and *Bambusa tulda* (mitingha). So, large number of bamboo culms consumption are cost increasing as well as increasing pressure on renewal resource because of frequently replacement in betel leaf farms. With the continuous growth of country's population and rising demand for bamboo materials, a gap between demand and supply is increasing. Therefore, demand and supply gap can be reduced either by increasing the bamboo production or by prolonging the service durability of the bamboo materials through preservative treatment.

Preservative or treated of bamboo means the protection of bamboo from influencing of chemical nature. A chemical treatment is usually inferred by combining copper sulphate, sodium dichromate and boric acid (CCB) at a ratio of 2:2:1 and with 90% of water solution (Younus-uzzaman 1998). Untreated means traditional or natural bamboo materials that is applying without chemical use in it. An attempt had been initiated over the last ten years or so, to disseminate the treated technology of bamboo materials of Bangladesh Forest Research Institute (BFRI) in making betel leaf farms structure to cope with the high demand and limited supply of bamboo resources. A substantial number of progressive farmers of western and northern districts of the country are already using treated bamboo materials to their field for more than last 10 (ten) years. So, it is important to assess the bamboo resource that are being saved and economic benefit of using treated bamboo materials and thereby generation of new employment opportunities in extending betel leaf farms for the growing number of rural population to contribute in our rural economy. This is the first time that has taken ever purposively selected to evaluate the adaptation of BFRI innovated preservative technology at farm level, whether it is economically viable or not in three districts (Barisal, Kushtia and Gaibandha) of the country.

The objective of the study is to determine the economic benefit of preservative/ treated bamboo materials as compared with untreated ones used in betel leaf farms.

Materials and Method

The total 967 hectares of betel leaf farms were

cultivated in three upazilas of the study areas (Agricultural office record of respective upazilla). A sample size of 30 (15 each of untreated and treated bamboo users) betel leaf farm families from each location were randomly selected. Simple Random Sampling (SRS) method was applied to determine input and output resources of betel leaf farms. Group discussion was performed with the selected farm families at Gournodi Upazilla of Barisal, Daulatpur of Kushtia and Polashbari of Gaibandha districts in the financial year of 2008-09, 2009-10 and 2010-11 respectively.

A designed schedule was followed to collect data from respondents in face to face interview method from each selected farm. The scheduled contained such issues as demographic information, socio-economic characteristics of the farm families, total land area and betel vines cultivated area, quantity used of input factors like; betel vine cutting, length and thickness basis splitting bamboo materials, jute sticks, rice straw, fertilizers, insecticide etc. and its' respective prices, labor cost and output factors of weekly plucking of betel leaves as well as quantification of seasonal variation of betel leaves yielding were recorded. Using untreated sticks of bamboo is a traditional practice in making farm structure. During cultivation, blocking and spacing of betel vine are followed almost same in standard measured in each location. Variations are observed among the sizes and yield of betel leaves in study areas. The required sizes of bamboo materials for using in betel leaf farms are available in the local market of the study areas. Use of the thickness basis traditional splitting bamboo materials in betel leaf farms are found generally 1 to 2 years but making these materials into treated form that are needed only 35% to 40% additional cost of existing traditional materials market price. After treating these bamboo materials then its' using durable period would be stand for at least 2 to 5 years. So, the progressive farmers of the study areas for preserving splitted bamboo materials in treatment plant are set up and already treating bamboo sticks in it (Preservation of bamboo, sun grass and wood- a proven technology of BFRI for prolonging service life of bamboo, wood, sun grass, etc.) (Anon, 1999). Untreated splitting bamboo materials practices were then followed by betel leaf farm families due to lack of treatment plant in their nearest areas. So, two groups of the betel Vine cultivators belongs to treated and untreated bamboo materials using farms were selected to observe the consumption of bamboo materials in their betel vine farms. Generally (4 to 8 types of) using splitted bamboo materials within eight types according to thickness and length size are used in betel leaf farms of the study areas. The different types of bamboo materials are used as follows:

i) Length of 2.5 meter thin sticks (type-1); kept vertical position for supporting betel vine in Gournodi.
ii) Length of 2.5 meter medium thick sticks (type-2); kept vertical position for supporting betel vine in Daulatpur and Polashbari.
iii) Length of 2.5 meter thick sticks (type-3); kept vertical position for holding vertically arranged type-1 in Gournodi and horizontal position for holding vertically arranged type-2 in Daulatpur.
iv) Length of 7.3 meter thin sticks (type-4); kept horizontal position for holding vertically arranged type 1, 2 & 3 in Gournodi and Polashbari.
v) Length of 7.3 meter thick sticks (type-5); kept horizontal position for fencing of farm's top structure in three locations.
vi) Length of 3.2 meter poles (type-6); untreated in Gournodi and treated items in Daulatpur and Polashbari are kept vertical position for setting betel leaves farm structure.
vii) Length of 9.15 meter thick sticks (type-7); untreated items are kept horizontally cross-direction with type-5 in Polashbari.
viii) Length of 9.15 meter poles (type-8); untreated items are kept horizontally to tighten with top structure and side protected fence of betel leaf farms in Polashbari.

Analytical methods

To determine the results of economic parameters on using treated as well as untreated bamboo materials in betel leaf farms of three locations, the

following formulas in Equations of 1 (Islam 2015) and 2-7 (Gittinger, 1982) were used in this analysis:

Resources mean, $\bar{y} = \frac{1}{m}\sum_{j=1}^{m} yj$ .....(1)

(Islam, 2015)

PVC (Present Value of Cost) $= \sum \frac{Cn}{(1+i)^n}$ .....(2)

PVB (Present Value of Gross Benefit)

$= \sum \frac{Bn}{(1+i)^n}$ .....(3)

PVNB (Present Value of Net Benefit)

$= \sum \frac{Bn}{(1+i)^n} - \sum \frac{Cn}{(1+i)^n}$ .....(4)

IRR (Internal Rate of Return)

$\sum \frac{Bn}{(1+i)^n} - \sum \frac{Cn}{(1+i)^n}$ .....(5)

Benefit Cost Ratio (B/C ratio)

$\sum \frac{Bn}{(1+i)^n} \div \sum \frac{Cn}{(1+i)^n}$ .....(6)

Incremental Net Benefit

$= \left(\frac{\text{PVNB of Treated farms}}{\text{PVNB of untreated farms}} - 1\right) \times 100$.....(7)

(Gittinger 1982)

Where y_j is the farm families of m numbers, m is the number of 15 each of treated and untreated farm, Cn is the cost in every n years, Rn is the returns every n years, n is the number of years that was considered as standard period of 10 years for the analysis of betel leaf farms, and i is the interest rate.

Results and Discussion

Socio-economic impact analysis was made considering a sample size of 30 (15 each of treated and untreated bamboo users) betel leaf farm families from each location.

Usable duration of treated and untreated bamboo materials

Length and thickness basis treated and untreated materials of splitting bamboo sticks were used in betel leaf farms and categorized these materials into eight types that were described earlier. Generally, the usable durability of splitting bamboo materials of various types in farms were for one to two years but the usable durability for thin sticks (type-1) of one year has been prolonged by two years and durability remaining other types has been prolonged at least five years after preserving bamboo materials (Table 1).

Table 1. Usable duration of treated and untreated bamboo materials in betel leaf farms of the study areas

Different length and thickness based bamboo materials	Usable duration (year) of splitting bamboo materials					
	Gournodi		Daulatpur		Polashbari	
	Untreated	Treated	Untreated	Treated	Untreated	Treated
Type-1	1	2	-	-	-	-
Type-2	-	-	1	5	1	5
Type-3	1	5	2	5	-	-
Type-4	2	5	-	-	2	5
Type-5	2	5	2	5	2	5
Type-6	2	-	2	5	2	5
Type-7	-	-	-	-	2	-
Type-8	-	-	-	-	2	-

Source: Field survey, 2008-09 to 2010-11.

Basic information regarding betel leaf farms

The surveys were conducted on betel leaf farms of the study areas in three different locations during **2008-09** to **2010-11** and basic information is shown in table 2. The ages ranged of participants were from 23 to 70 years. The literacy rate of betel leaf farm families were found highest in Gournodi (47%) and were the lowest in Polashbari (39%) with a weighted mean of 43%. Average land area across the locations was the lowest in Polashbari and was the highest in Daulatpur and area in decimal (dec.) of 149 to 208 with a weighted mean of 175 decimal and betel vine cultivated area was the lowest in Gournodi (26 dec.) and was the highest in Daulatpur (65 dec.) with a weighted mean of 40 decimal and that was 15% to 31% of their total land areas.

Leaves of betel vine is, normally sprouted twice in a year and a number of 18 to 22 leaves are sprouted once in a betel vine, only 70% of total produce leaves of betel vine were considered for the analysis and produce of betel leaves and its' sale was considered to remain the same for the period of ten years. The recorded yearly yield of betel leaves per hectare was the highest 269 *gadhy* in Polashbari and was the lowest 256 *gadhy* in Gournodi (*gadhy* means a total number of 6,400 betel leaves) with a weighted mean of 263 *gadhy*. The market prices of betel leaves under three locations were ranged from Tk. 4,000 to Tk. 5,540 per *gadhy* with a weighted mean of Tk. 4,673. But, reportedly found that 25% in Kustia and Gaibandha and 50% in Barisal districts were the initial year yield of mean betel leaves production in the study areas.

Table 2. Basic information regarding betel leaf farms of the studies areas

Variables	Selected study areas of betel leaf farms			Weighted mean
	Barisal (Gournodi)	Kustia (Daulatpur)	Gaibandha (Polashbari)	
Survey year	2008-09	2009-10	2010-11	-
Total betel vine cultivated areas (ha)	705	227	34.28	-
Number of sample participants	30	30	30	-
Age range of participants (years)	23-70	24-70	23-65	-
Literacy (%)	47	42	39	43
Average land area of farm family (decimal)	168	208	149	175
Average betel leaf farm areas (decimal)	26	65	29	40
Betel vine (%) of other land areas	15	31	19	22
Yield of betel leaves as gadhy* (no/ha/year)	256	265	269	263
Average price of betel leaves (Tk/gadhy)	4000	4480	5540	4673

(**Gadhy* means a number of 6,400 betel leaves)

Estimation of surplus/saving bamboo resources

A number of treated and untreated splitting bamboo materials in various lengths using in betel leaf farms are shown in table 3. Impacts of the using treated bamboos materials with untreated ones were assessed. A comparison of treated bamboo materials with untreated ones in using betel leaf farms were made for the period of 10 years. An estimated 1600 thousand type 1 untreated materials of splitting bamboo per hectare were used in betel leaf farms of Barisal but making it into treated form that were needed only 800 thousand per hectare for the same period. So, an amount of splitting bamboos 224, 12.50 & 17.50 thousand that were types of 3, 4 and 5 for untreated materials were used in betel leaf farms of Barisal, but if the materials of those to be

in treated form that were needed only 44.8, 5 and 7 thousand respectively. Accordingly, the amount of splitting bamboos 1212.12, 75.76, 7.58 and 37.88 thousand types of 2, 3, 5 and 6 for untreated materials were used in Kustia and 1280, 10, 10 and 9 thousand were used in Gaibandha and while these types of bamboo materials were to be in treated form and the amount required only were 242.42, 30.30, 3.03 and 15.15 thousand in Kustia and 320, 4, 4 and 3.75 thousand in Gaibandha (Table 3) respectively.

Table 3. Requirement of splitting bamboo treated and untreated materials (nos. ha^{-1}) in betel leaf farms for the period of 10 (ten) years in the study areas

Different length based bamboo materials & involved laborers	Required thousand number of materials ha^{-1} for 10 years					
	Barisal		Kustia		Gaibandha	
	Untreated	Treated	Untreated	Treated	Untreated	Treated
Type-1	1600.00	800.00	-	-	-	-
Type-2	-	-	1212.12	242.42	1600.00	320.00
Type-3	224.00	44.80	75.76	30.30	-	-
Type-4	12.50	5.00	-	-	10.00	4.00
Type-5	17.50	7.00	7.58	3.03	10.00	4.00
Type-6	43.75	-	37.88	15.15	9.38	3.75
Type-7	-	-	-	-	4.00	-
Type-8	-	-	-	-	3.00	-
Laborer	49.89	48.69	52.56	50.88	52.53	50.94

Surplus of bamboo materials

The saving or surplus splitting bamboo materials of various types and laborers as well as its' percentage due to the adaptation of treated bamboo materials in betel leaf farms are shown in table 4. The materials of splitting bamboos and laborers surplus were estimated for the age period of ten years of betel leaf farms. The percentage surplus of laborer and bamboo materials in various types estimated were 2 and 63 in Barisal 3 and 65 in Kustia and 3 and 64 in Gaibandha respectively and with its' overall weighted mean percentage were estimated about 3 and 64 for the betel leaf farms of three locations (Table 4).

Table 4. Surplus (saving) inputs of betel leaf farms due to have practicing treated bamboo materials

Different length based bamboo materials & laborer	Surplus or saving bamboo materials					
	Barisal		Kustia		Gaibandha	
	Nos./year	(%)	Nos./year	(%)	Nos./year	(%)
Type-1	80,000	50	-	-	-	-
Type-2	-	-	96,970	80	1,28,000	80
Type-3	17,920	80	4,545	60	-	-
Type-4	750	60	-	-	600	60
Type-5	1,500	60	455	60	600	60
Type-6	-	-	2,273	60	563	60
Laborer	120	2	168	3	159	3
Average types of bamboo materials (%) saving	-	63	-	65	-	65

Saving of bamboo culms

A number of the saving bamboo culms (Table 5) that were reverted from the surplus/saving bamboo materials in various types and which were mentioned in earlier table 4. The number of bamboo culms saving were 374, 560, 30 and 75 from the bamboo materials types of 1, 3, 4, and 5 for the location of Barisal, so, the number of bamboo culms 909, 85, 57 and 162 from the types of 2, 3, 5 and 6 for Kustia and 667, 38, 38, and 188 from the types of 2, 4, 5 and 6 for Gaibanha respectively. Therefore, the overall saving mean number of bamboo culms was 1127 ha.$^{-1}$ year^{-1} due to have practicing treated bamboo materials in betel leaf farms of the study areas.

Table 5. The saving bamboo culms ha^{-1} year^{-1} that is reverted from the surplus bamboo materials of betel leaf farms

Different length based bamboo materials	Saving number of bamboo culms ha^{-1}year^{-1}		
	Barisal	Kustia	Gaibandha
Type-1	374* (748)	-	-
Type-2	-	909	889*(1778)
Type-3	560	85	-
Type-4	30	-	38
Type-5	75	57	38
Type-6	-	162* (324)	188
Total saving/surplus	1016	1213	1151

* The saving number of bamboo culms considered only 50% and remaining bamboo culms were adjusted from top portion of bamboos which had as wastage after making thicker items of bamboo materials.

Demand and saving of bamboo culms

The demand of bamboo culms in using treated and untreated bamboo materials in betel leaf farms for making or repairing farms structure and surplus number of bamboo culms are shown in figure 1. The required number of bamboo culms in untreated bamboo materials using farm estimated were 1626, 1867 and 1771 per hectare per year for Barisal, Kustia and Gaibandha respectively in making or repairing farm structure. The overall mean number of bamboo culms estimated for the study areas was 1755 (SE±70). But, in case of practicing treated bamboo materials in farms, the demand of bamboo culms needed were only 610, 653 and 620 for Barisal, Kustia and Gaibandha respectively and its' overall average required number of bamboo culms was 628 (SE ± 13).

So, the significant numbers of bamboo culms were surplus due to adaptation of bamboo material in betel leaf farms. The saving number of bamboo culms were 1016, 1213 and 1151 for Barisal, Kustia and Gaibandha respectively per hectare per year and of which the overall average surplus number of bamboo culms was 1127 (SE ± 58).

Figure 1. Demand and saving bamboo culms ha^{-1} $year^{-1}$ in untreated and treated betel leaf farms of the study areas

Investment and net profit patterns

The investment cost of betel leaf farms is defined as the outlaying on input of permanent and casually hired workers, land preparation, transplanting of betel vine, splitting bamboo items (treated or untreated materials), jute stick, roofs, rice straw, organic and inorganic fertilizer, etc. and as output of farm produce like betel leaves sale and salvage value of replaceable bamboo materials, jute stick and rice straw etc. as fuel were included for the analysis of betel leaf farms. Using of splitting bamboo materials in betel leaf farms were the prime issue to compare the treated materials with untreated ones in making economic impact in betel leaf farms of the study areas. In this survey, the price of untreated materials was 29% of total cost but if that was in treated form, price needed only 23% of total cost in Barisal. Accordingly, the prices of untreated materials were 23% and 28% of total cost for Kustia and Gaibandha but if those materials were in treated form and that were needed only 10% and 13% of total cost respectively. These reduced percentages of total cost as well as reducing the usage of bamboo resources were only possible for the adaptation of treated materials in betel leaf farms. So, economic analyses were made individually for treated and untreated farm of the study areas. The net profit is referred here as annual gross value of farm output minus annual investment of the treated and the untreated bamboo materials using betel leaf farms per hectare.

In this survey, yearly investment and net profit for the betel leaf farm age period of ten years of the untreated and treated materials using farms per hectare for Barisal, Kustia and Gaibandha districts of the study areas. These are shown in figures 2 (a), 2 (b) and 2 (c).

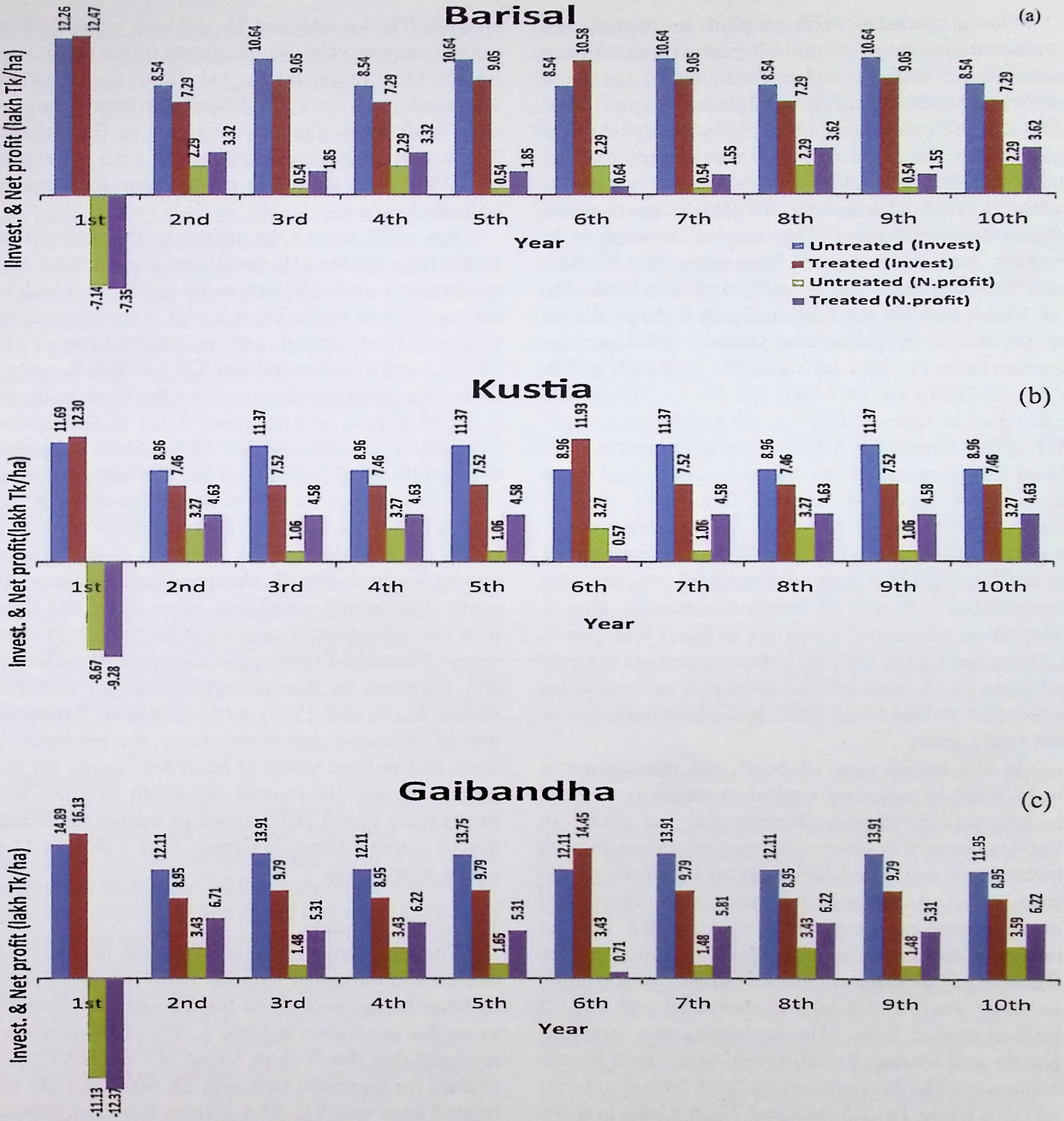

Figure 2. Investment & net profit (lakh Tk.) on betel leaves of two types farm ha^{-1} for the period 10 years of the study areas **(a)** Barisal, **(b)** Kustia and **(c)** Gaibandha.

The investment with respect to capital and replacement cost at 1st and 6th year of treated farm were found slightly higher than that of untreated ones in all locations of the study areas, i,e, at 1st and 6th year, the corresponding capital and replacement costs for the treated farm estimated were Tk.12.5 lakh and Tk. 10.6 lakh, and for the untreated ones were Tk. 12.3 lakh and Tk. 8.5 lakh respectively in figure 2 (a) of Barisal. The cost for the same at 1st and 6th year in the treated farm were Tk. 12.3 lakh and Tk. 11.9 lakh and in untreated ones were Tk. 11.7 lakh and Tk. 9.0 lakh in figure 2 (b) of Kustia respectively. In Gaibandha district, this cost for treated farm Tk. 16.1 lakh and Tk. 14.5 lakh and in untreated farm Tk. 14.9 lakh and Tk. 12.1 lakh were estimated at figure 2 (c). So, the replacement costs for other remaining years of targeted period for betel leaf plantations age was determined and these costs were lower in treated farm than that of untreated ones for all locations due to have practicing of bamboo treated materials. The investment of yearly replacement cost was reduced crucially for the surplus (saving) of bamboo materials due to adaptation of treated materials in betel leaf farms. Consequently, the net profit were increased in treated farm of all most all the even and uneven years except in 1st and 6th of betel leaf plantations age of the study areas.

In the initial year of betel leaf plantations, a little yield in terms of capital investment of betel leaves was produced; thereby its' net profit in bar-diagrams was observed negative values in both treated and untreated farms in all locations of the study areas. At the age of 2nd year, replacement and management cost estimated was Tk. 8.5 lakh in untreated farms while Tk. 7.3 lakh in treated ones in figure 2 (a) of Barisal. The net profit for the same location was Tk. 2.3 lakh in untreated and Tk. 3.3 lakh in treated farm. The remaining two locations Kustia and Gaibandha, followed with costs for the same were Tk. 9.0 lakh and Tk. 12.1 lakh in untreated farm while Tk. 7.5 lakh and Tk. 8.9 lakh in treated ones at figure 2 (b) and figure 2 (c) respectively. Accordingly, net profits for the same locations were Tk. 3.3 lakh and Tk. 3.4 lakh in the farm of untreated while Tk. 4.6 lakh and Tk. 6.7 lakh in the farm of treated respectively. So, the mean of net profit was found 51% more in treated farm than that of untreated ones over the period for even years of betel leaf farms plantation age 10 in Barisal and followed by Kustia and Gaibandha with the values of 42% and 83% more in treated farm than that of untreated ones.

But, at 3rd among the uneven years of betel leaf farms for targeted (10 year) age, replacement and management cost was estimated as Tk. 10.6 lakh in untreated farm while Tk. 9.1 lakh in treated ones in figure 2 (a) of Barisal, and its' net profit were Tk. 50 thousand in untreated and Tk. 1.9 lakh in treated farm. The corresponding cost for the same in figure 2 (b) of Kustia and in figure 2 (c) of Gaibandha were Tk. 11.4 lakh and Tk. 13.9 lakh in untreated farm while Tk. 7.5 lakh and Tk. 9.8 lakh in treated ones. Net profits for the same locations were Tk. 1.1 lakh and Tk. 1.5 lakh in the farm of untreated while Tk. 4.6 lakh and Tk. 5.3 lakh in the farm of treated respectively. So, the mean percentage of net profit determined was 213% more in treated farm than that of untreated ones over the period for even years of betel leaf farms plantation age 10 in Barisal and followed by Kustia and Gaibandha with the values 331% and 253% more in treated farm than that of untreated ones respectively. So, irrespective even and uneven years of betel leaf farms for the plantation age 10, overall net profit of betel leaf farms were found 163% more in treated farm than that of untreated ones in figures 2 (a), 2 (b) and 2 (c) of the study areas.

Economic Impact

The economic impacts of partial analysis for treated and untreated bamboo materials using farm of betel leaves was made for the age period of 10 years that are shown in table 6. The analysis results revealed that the Present Value of Cost (PVC) per hectare for untreated farm was Tk. 60.7 lakh and for treated ones was Tk. 55.4 lakh in Barisal followed by Kustia and Gaibandha cost for the same Tk. 63.1 lakh and Tk. 52.9 lakh in treated farm and Tk. 80.9 lakh and Tk. 66.6 lakh in untreated ones respectively.

The Present Value of Gross Benefit (PVGB) and Present Value of Net Benefit (PVNB) were Tk. 62.5 lakh and Tk. 1.8 lakh in Barisal, Tk. 67.3 lakh and Tk. 4.3 lakh in Kustia and Tk. 84.6 lakh and Tk. 3.5 lakh in Gaibandha for untreated farm per hectare. But in treated farms those indicators were Tk. 61.5 lakh and Tk. 6.1 lakh in Barisal, Tk. 66.4 lakh and Tk. 13.5 lakh in Kustia and Tk. 83.3 lakh and Tk. 16.8 lakh per hectare in Gaibandha respectively. This substantial benefit in treated farms were only possible due to the savings of 3% and 64% labor force and bamboo materials respectively. The Present Value of Net Benefit in Gaibandha was four times higher, in Barisal and Kustia that parameter was three times higher in treated farm than that of untreated ones in the study areas. So, overall incremental net benefit of treated farm was 282% higher than that of untreated ones in the study areas. The Internal Rate of Return (IRR) for treated betel leaf farms were 31%, 45% and 44% and for untreated ones were 16%, 23% and 18% in Barisal, Kustia and Gaibandha respectively. The benefit cost ratios (B-C ratio) of untreated farms were 1.03, 1.07 and 1.04 for Barisal, Kustia and Gaibandha respectively, whereas in treated farm, these were, accordingly 1.11, 1.26 and 1.25. Those parameters clearly indicate that the use of treated materials in betel leaf farms were profitable as well as have strong business potentials.

Table 6. Partial economic impact analysis of using untreated and treated bamboo materials in betel leaf farms in three districts of the study areas

Economic criteria	Barisal		Kustia		Gaibandha	
	Untreated	Treated	Untreated	Treated	Untreated	Treated
Present Value of Cost (Lakh Tk./ha)	60.7	55.4	63.1	52.9	80.9	66.6
Present Value of Gross Benefit (Lakh Tk./ha)	62.5	61.5	67.3	66.4	84.6	83.3
Present Value of Net Benefit (Lakh Tk./ha)	1.8	6.1	4.3	13.5	3.5	16.8
Internal Rate of Return (IRR)	16%	31%	23%	45%	18%	44%
Benefit-Cost (B-C) ratio	1.03	1.11	1.07	1.26	1.04	1.25

Conclusion

The economic impact analysis regarding two types of treated and untreated farm was made for the period of 10 years. Treated farm was found highly profitable as well as plentiful number of bamboo culms are being saved due to adaptation of preservative technology in the study areas. So, the benefit due to adaptation of treated bamboo materials in betel leaf farms in study areas are -

- Surplus of bamboo resources - 64%
- Surplus of labor force- 3%
- Reduction of investment and management cost- 15%
- Net benefit increased more than three times higher.
- Contribute to livelihood of betel leaf farm families in desired level.

Ninety percent of the total betel leaf farms (14,175 hectares) are using splitting bamboo materials. If treated bamboo materials are applied to cover 90% of total farms, thereby, a huge number of 1.44 crore bamboo culms would be able to surplus or save in betel leaves farming sector of the country. The farm in using treated bamboo materials has become a promising as well as exponentially profitable sector. Due to that reason, the cultivated areas and yield of betel leaf farms are expanding overtime and thereby more yields would be able to increase and quantity of betel leaves export would be increased in order to earn more foreign currency. Minimized marginal cost of betel leaf farm resulting low price and ultimately consumer group would be benefited throughout the country.

Therefore, bamboo resources play vital role in

maintaining the balance of natural environment. At present, to meet up the national resources requirement, people are involved in destroying this balance keeping forest resources indiscriminately and that is affecting the environment adversely. If it is made and implement the treatment plant in making bamboo materials into treated form for using in betel leaf farming throughout the country, it will be possible to reduce the demand about 1.44 crore bamboo culms (price of per bamboo culms Tk.120) as well as will reduce about Tk. 172.8 crore replacements investment cost in that sector every year.

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