



An economic analysis of Jara and Colombo lemon production in Bangladesh

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Abstract

The study was conducted in two districts namely Sylhet and Narsingdi to investigate the production technology of Jara and Colombo lemon growers, estimate profitability and identify the constraints of Jara and Colombo lemon. A total sample of 120 farmers taking 60 for Jara lemon from Sylhet and 60 for Colombo lemon from Narsingdi was selected randomly for the study. Data were collected through face to face interview method by using structured questionnaire during April–May, 2016. Cost return analysis revealed that Jara and Colombo lemon cultivation were profitable in the study areas. Jara lemon cultivation highest cost was estimated Tk. 413575/ha in (11–15)th year garden and lowest cost was Tk. 365777/ha in 2nd year garden. Gross return was highest in 5th year garden (Tk.1995750/ha) and lowest Tk. 975600/ha in (11–15)th year garden. The benefit cost ratio at 6.5% rate of interest was 2.85 and IRR 78%. Colombo lemon cultivation highest cost was estimated Tk. 316505/ha in 4th year garden and lowest cost was Tk. 257543/ha in (11–15)th year garden. Gross return was highest Tk. 841522 in 5th year garden and lowest Tk. 413616/ha in (11–15)th year garden. The benefit cost ratio at 6.5% rate of interest was 1.81 and IRR 65%. Lack of improved production technology, poor quality saplings, insect/pest infestation, adulteration of fertilizer and insecticides and less number of export buyers were found major constraints both Jara and Colombo lemon production.

Introduction

Citrus species are small to medium-size shrubs or trees that are cultivated throughout the tropics and subtropics. They are native in some parts of India, China, and Northern Australia. Citrus is adaptable to many subtropical, tropical environments and soils has traditionally been cultivated on home gardens. Lemon is very important citrus among many types of citrus fruits produced in Bangladesh. Soil and temperature of Bangladesh is favorable for lemon cultivation. In Bangladesh, about 54,613 M. ton of lime and lemon are grown annually in 4,083 hectares of land (BBS, 2011). Lemon contains large quantity of citric acid (4.52% to 5.82%). It is one of the most important fruits in international trade as fresh fruit and processed product. Roughly, 10% of the citrus produced in the world enters into international trade as fresh fruit. With globalization of world trade and establishment of world trade organization (WTO) the export opportunities of citrus fruits increase significantly. Therefore, citrus grower faced increase competition in the world market level. Lemon is used as raw materials of shampoo, soap, medicine and various delicious items like salad, drink, jam, etc. Day by day lemon demand is expanding for which it is necessary to know the current method of production as well as return for increasing its yield. To meet the requirements of various importing countries it is essential for exporters to ensure that the quality of lemon is of the required standards. In Bangladesh, the productivity per unit area and overall production need to

be increased considerably in order to stand in international competition.

Citron (*Citrus medica*) is called “Jara Lebu” in Bangladesh. India is commonly considered as the origin location of Citron. In India, citron was found under wild conditions particularly in Nilgiris, Assam and lower Himalayas (Yaquis Liu *et al.*, 2012). Jara lemon is the first citrus fruit that is exporting from Bangladesh to Europe. The countries of European Union, gulf region such as Kuwait, Saudi Arabia, UAE and Qatar are potential markets for Jara lemon in Bangladesh. Due to attack on canker disease European Union banned Jara lemon import from Bangladesh in 2008. Jara lemon a big variety of local citrus to European countries has got a big boost over kingdom was withdrawn in November last year (DAE, 2012).

According to plant protection wing of Department of Agricultural Extension (DAE), 106 tons of Jara lemon was exported from November 2011 to May this 2012 (source: The daily Independent, 30 July, 2012). By exporting lemon to the world market, production can be increased. So, the present attempt has been made to focus the export marketing performance of Jara and Colombo lemon. This study will also emphasize the production and productivity, profitability and cultivation problems and constraints to policy reform option for problem solution and strengthening the lemon subsector. The present study will be helpful for lemon growers,

scientist, exporters, policy makers to formulate Jara and Colombo lemon improvement and development policy and implementation. This study will build a foundation for further research on the present background. Therefore, the present study was undertaken with the following specific objectives are: (a) to investigate the production practices at farmers' field; and (b) to explore the profitability and sensitivity analysis of cost and return changes of lemon production.

Materials and Methods

Multi-stage sampling technique was followed for the study. The study was conducted in purposively selected two districts namely Narsingdi and Sylhet. A total of 120 samples 60 for Jara lemon from Sylhet and 60 samples for Colombo lemon from Narsingdi district were randomly selected for interview. Data were collected by experienced field investigators with the direct supervision of the researchers using a structured interview schedule.

Data were categorized according to the year of cultivation. The age of the lemon garden were classified like 1st year, 2nd year, 3rd year, 4th year, 5th year, (6-10)th year and (11-15)th year. Then the collected data were edited, summarized, tabulated and analyzed to fulfill the objectives of the study. Tabular methods of analysis using descriptive statistics were used in presenting the results of the study.

Benefit-Cost Analysis is a technique for evaluating a project or investment by comparing the economic benefits with the economic costs of the activity. BCA can be used to evaluate the economic merit of a project. Second the results from a series of benefit-cost analysis can be used to compare competing projects. BCA can be used to assess business decision, to examine the worth public investments, or to assess the wisdom of using natural resources or altering environmental conditions. Ultimately, BCA aims to examine potential actions with the objective of increasing social welfare (*Boardman, et al., 1996*). In most developing countries the best discount rate to use is the "opportunity cost of capital" is assumed to be somewhere between 10–12% (*Gittinger, 1977*). In recent years opportunity cost of capital calculated by the interest rate of bank deposit. Last few years interest rate of bank deposit nearby 6–8 % in all commercial bank in Bangladesh (BB, 2014).

$$BCR = \frac{\text{Present Value of Cash Inflows}}{\text{Present Value of Cash Outflows}}$$

$$\text{Benefit cost ratio} = \frac{\sum_{t=1}^{t=n} \frac{B_t}{(1+t)^t}}{\sum_{t=1}^{t=n} \frac{C_t}{(1+i)^t}}$$

NPV: The net present value (NPV) is the current value of all project net benefits. Net benefits are simply the sum of benefits minus costs. The sum is discounted at the discount rate. Using this method, if the project has a NPV greater than zero then it appears to be a good candidate for implementation. The formula used to calculate at NPV:

$$NPV = \sum_{t=0}^T \frac{CF_t}{(1+r)^t}$$

IRR: The internal rate of return (IRR) is the maximum interest that could be paid for the project resources, leaving enough money to cover investment and operating to break even. In other words, the IRR is the discount rate for which the present of total benefits equal the present value of total cost. In general the IRR should be greater than the discount rate for a project to be accepted.

$$IRR = L + \frac{NPV \text{ at } L}{NPV \text{ at } L - NPV \text{ at } H} \times (H - L)$$

L= Lower discount rate
H = Higher discount rate

Results and Discussion

Profitability Analysis of Jara Lemon Production

Production technology of Jara lemon in Sylhet area:

This study was done Jaintapur upazila under Sylhet district having found different types of land category for Jara lemon cultivation. It was found that maximum garden established on high land. Considering soil type most of the garden having found sandy loamy soil on the basis of farmer's opinion. Department of Agricultural Extension (DAE) and Citrus Research Centre motivate farmer for involving Jara lemon cultivation. Sample farmers were asked why they are involving Jara lemon cultivation. More profit, low cost and less labour intensive crop was the main reason chooses for Jara lemon cultivation. Most of the farmers purchase saplings from market and neighbor garden. The best planting time of lemon garden is the end of the rainy season whereas the farmers in the study area planted generally during June to October. They used grafting method seedling their garden. They prepared their land by spading.

Table 1. Production practices of Jara and Colombo lemon in the study areas

Production practices	Jara lemon	Colombo lemon
	Sylhet	Narsingdi
Types of land: (%)		
High land	50	-
Medium high land	30	20
Plain land	20	80
Types of soil: (%)		
Sandy soil	-	-
Loamy soil	-	75
Sandy loamy soil	100	25
Sources of seedling: (%)		
Own garden	20	20
Market/neighbor garden	80	80
BADC	-	-
Time of plantation : (%)		
July	60	70
August	30	30
September	10	-
Plant to plant distance (meters)	3	3
Deepness of pit (c.m.)	36	15
Times of cowdung application per year	6.5	8.5
weeding (times/year)	2.3	3.5
No. of insecticides (times/year)	4.6	4.2
Times of irrigation (no./year)	2.4	4
Insecticides and pest attack	leaf minor, sun metric, cancer, lemon butterfly, gummosis	

Source: Field survey, 2016.

The average plant to plant and line to line distances 3 meter and 3 meter, respectively. The average deepness of pit 36 c.m. The average number of weeding in different year was found 4–6 times. On average number of irrigation was found 2–4 times. Hundred percent farmers used burdo mixer after pruning. Farmers in the survey area mentioned that their garden attack by leaf minor, lemon butterfly, canker and red mite in different times. In case of leaf minor attack farmer used sun metric, for cancer they used kuprovit, lemon butterfly attack they used epitaph and red mite attack they used vartimax (Table 1).

Farmers in the survey areas applied different does of fertilizer their garden. When garden age 1–2 years farmers opined that on average they used 15 kg cow dung, 150gm urea, and 220 gm TSP per tree. When garden age 3–5 years farmer applied average 30 kg cow dung, 60 gm urea, and 70 gm TSP per tree. Above 5 years old garden farmers applied 21kg cow dung, 140gm urea, and 180 gm TSP per tree. 50% farmers applied 2 times fertilizer in a year. 20% farmers applied 2–4 times fertilizer in a year and rest of the farmers applied above 4 times fertilizer application which is below than recommendation doses of manures and fertilizers (*BARI handbook, 2014* (Table 2).

Table 2. Fertilizers application at different years old garden

Age of plant	Cowdung (kg)	Urea	TSP
1–2 years	15	150gm	220gm
3–5 years	30	60gm	70gm
5–avobe	21	140gm	180gm

Source: Field survey, 2016.

Input use: Human labour was required for land development, planting, application of manures, fertilizing, spraying, weeding, irrigation and harvesting. The number of human labour varies from one year

another year due to change in number of weeding, spraying insecticides, irrigation and harvesting. In the first year garden, on average 500 man-days/ha was required for its cultivation.

Table 3. Per hectare input used for Jara lemon cultivation in Sylhet area

Parameters	Period of cultivation(year)						
	1	2	3	4	5	6-10	11-15
Human labour (man-days)	500	450	460	458	465	464	425
Own	113	156	163	146	165	181	145
Higher	287	111	112	142	122	99	106
Seedlings/saplings (no.)	1024	935	954	896	847	834	813
Cowdung (kg)	82460	76460	85006	90472	91472	84720	96720
Urea(kg)	767	674	768	501	806	778	912
TSP(kg)	364	408	372	416	393	390	480
MP(kg)	367	570	580	603	580	574	880
Insecticides (times)	2-3	4-7	4-8	4-8	4-10	4-7	3-6
Pesticides (times)	1-2	2-3	3-4	2-3	1-4	3-4	3-4
Irrigation(no.)	4	3.6	3.4	3.5	4.2	3.9	3.1

Source: Field survey, 2016.

Highest number of human labour (500 man-days/ha) was found in 1st year garden and lowest number of human labour (425 man-days/ha) at (11-15)th year garden. Manure and fertilizer is essential for better production of Jara lemon. In the survey area farmer apply cowdung, TSP, MoP, and Urea. In first year lemon garden farmers used on average 82460kg cowdung, 767kg Urea, 364kg TSP, 367kg MoP per hectare. In second year lemon garden farmers used on average 76460kg cowdung, 674kg Urea, 408kg TSP, 570kg MoP per hectare. In third year lemon garden farmers used on average 85006kg cowdung, 768kg Urea, 372kg TSP, 580kg MoP per hectare. In fourth year lemon garden farmers used on average 90472kg cowdung, 501kg Urea, 416kg TSP, 603kg MoP per hectare. In fifth year lemon garden farmers used on average 91472kg cowdung, 806kg Urea, 393kg TSP, 580kg MoP per hectare. In (6-10)th year lemon garden farmers used on average 84720kg cowdung, 778kg Urea, 390kg TSP and 574kg MoP per hectare. In (11-15)th year lemon garden farmers used on

average 96720 kg cowdung, 912 kg Urea, 480 kg TSP and 880 kg MoP per hectare (Table 3).

Cost of Production: Cost of production including human labour, seedling/saplings, manures, fertilizers, pesticides, land development, irrigation and pillar/support etc. Rental value of land was treated as fixed cost and shown in total costs. Interest on operating capital calculated on the basis of opportunity cost of variable cost that was used in Jara and Colombo lemon. The interest rate assumed the savings rate of bank deposit that was 8%. Land development and saplings costs were involved only during first year. Highest cost was estimated Tk. 413575/ha in the (11-15)th year garden and the lowest cost was observed Tk. 365777/ha in 2nd year garden (Table 3). Among the cost items Jara lemon cultivation human labour incurred the highest cost and second highest cost was found in cowdung and fertilizer application (Table 4).

Table 4. Per hectare cost of Jara lemon cultivation in the Sylhet area (in Tk./ha)

Parameters (Tk. /ha.)	Period of cultivation (year)						
	1	2	3	4	5	6-10	11-15
Sample number	8	8	8	8	8	10	10
Human labour	150000	135000	138000	137400	139500	139200	127500
Saplings	25600	-	-	-	-	-	-
Cow dung	98952	91752	102007	108566	109766	101664	116064
Urea	12300	14450	13650	12546	12897	12453	14600
TSP	8000	8965	8560	12500	8650	8596	10563
MP	6230	10254	9875	10254	9876	9758	14963
Gypsum	-	7320	7450	12450	12458	12654	13659
Insecticides	5000	12450	12360	9548	15483	15879	16985
Pesticides	12560	-	-	6580	7562	8630	13658
Irrigation	15000	14236	14560	12540	12550	11986	10693
Bamboo	-	20000	25360	23650	15000	10000	20000
Interest on opt. capital	26691	25154	26545	27682	27499	26065	28694
Rental value of land	26196	26196	26196	26196	26196	26196	26196
Total cost(Tk.)	386529	365777	384563	399912	397437	378081	413575

Source: Authors' calculation based on field survey, 2016.

Yield and gross return: After two year of seedlings/saplings Jara lemon production start and continue ten to fifteen years old tree. Yield was increasing from 2nd year to 5th year garden and it declined thereafter. Price was varying quality of lemon and season to season. Last year farmer got average price Tk. 80 per kg lemon. The average highest yield was found 26610 piece/ha at 5th year garden and lowest yield

12195 piece/ha at (11–15)th year garden. The highest gross return was found in Tk. 1995750 for 5th years garden and lowest return was Tk.975600 in (11–15)th years gardens. Highest gross margin was found Tk. 1624509/ha at 5th year garden and lowest Tk. 588221/ha in (11–15)th year garden. Net return was negative in 1st and 2nd year garden because production was zero (Table 5).

Table 5. Profitability of Jara lemon in Sylhet area

Items	Period of cultivation(year)						
	1	2	3	4	5	6-10	11-15
Sample number	8	8	8	8	8	10	10
Yield (kg/ha.)	0	0	14310	21692	26610	20016	12195
Unit price (Tk./kg)	-	-	86	84	75	73	80
Gross return/Total income (Tk./ha.)	-	-	1230660	1822128	1995750	1461168	975600
T. Variable cost (Tk./ha.)	360333		358367	373716	371241	351885	387379
Gross margin (Tk./ha.)			872293	1448412	1624509	1109283	588221
Total cost (Tk./ha.)	386529	365777	384563	399912	397437	378081	413575
Net return (Tk./ha.)	-386529	-365777	846097	1422216	1598313	1083087	562025
Benefit Cost Ratio(BCR)	-	-	3.20	4.55	5.02	3.86	2.35

Source: Authors' estimation based on field survey, 2016.

BCR, NPV and IRR

Discounting is a technique that converts all benefits and costs into their value in the present. The rate at which a future value is discounted is closely related to the rate at which present values are compounded, namely interest rate whenever the benefits and costs used in a benefit-cost analysis occur in the table, it is important to discount these future values to account for their present value. To calculate benefit-cost ratio (BCR), net present

worth (NPV) and internal rate of return (IRR) the cost and returns was discounted at 6.5% rate of interest.

Benefit cost ratio for Jara lemon Sylhet area 2.85, which is greater than one, it means Jara lemon gardening is profitable. Net present value was Tk. 6816510/ha which also indicated profitability of Jara lemon garden. Internal rate of return was found 98%, indicated the IRR greater than the discount rate for a project to be accepted (Table 6).

Table 6. Summary of original BCR, NPV, IRR and sensitivity analysis for Jara lemon

Lemon	location	Criteria	BCR at 6.5%	NPV at 6.5%	IRR at 6.5%
		Original	2.85	6816510	78
Jara lemon	Sylhet	10% increase in cost	2.59	6449800	73
		10% decrease in return	2.57	5768149	71

Source: Authors' calculation based on field survey, 2016.

Sensitivity analysis: To make a valid generalization it is necessary to conduct sensitivity analysis. By doing sensitivity analysis under different conditions know that what happens profitability of Jara lemon. It was observed from Table 6 that BCR was greater than one. NPV was positive at 6.5% discount rate and IRR was also higher than the opportunity cost of capital. This implies that if the returns decrease at 10% or total cost increases at 10%, the owner of Jara lemon can make profit. Analyzed result show that Jara lemon growers can earn profits under changing situation.

different types of land for lemon cultivation. Highest percentage of all farmers 80% used plain land for lemon cultivation and 20% used medium high land. Considering soil type of lemon cultivation it was found that 75% farmer cultivated on land of loamy soil and 25% farmer cultivated on land of sandy loamy soil. Farmers in the survey area generally used power tiller for land preparation. About 90% farmer used power tiller for land preparation, 5% used tractor and rest of them used spade.

Profitability Analysis of Colombo Lemon Production

Production technology of Colombo lemon in Narsingdi area: Farmers in the survey areas had

In the survey area 100% farmer used grafting for seedling/saplings. 80% farmers mentioned that collection of Colombo lemon saplings from nearest nursery and 20% farmer collected from market at first stage and laterally they make their own garden. The best

planting time of Colombo lemon at the end of the rainy season whereas in the study areas farmer started from June and continued up to August. Farmers make pit before 15-20 days. The average Plant to plant and line to line distance was found 3 meters and 3 meters, respectively as practiced by the farmer. Deepness of pit was found 15c.m. Most of the farmers maintain row their garden. The average number of cowdung application, fertilizer application, weeding, number of spraying and irrigation 8.5, 3, 3.5, 4.2 and 4 times, respectively (Table 7).

Input use: Human labour was required for land development, planting, application of manures, fertilizing, spraying, weeding, irrigation and harvesting. The number of human labour varies from one year another year due to change in number of weeding, spraying insecticides, irrigation and harvesting. In the first year garden, on average 383 man-days/ha was required for its cultivation. Highest number of human labour was found in 5th year garden and lowest number of human labour 11-15th year garden. Proper dose of fertilizer application is essential for better production

Colombo lemon growers in Norsingdi area used cowdung, TSP, MP, Urea, etc. In first year lemon garden farmers used on average 79040 kg cowdung, 741kg TSP, 787 kg MoP, and 800 kg urea per hectare. In second year lemon garden farmers used on average 90650kg cowdung, 557kg TSP, 605 kg MoP and 726 kg Urea per hectare. In third year lemon garden farmers used on average 92648 kg cowdung, 509kg TSP, 639kg MoP, and 849 kg Urea per hectare. In fourth year lemon garden farmers used on average 108460 kg cowdung, 521kg TSP, 784 kg MoP, and 771 kg Urea per hectare. In fifth year lemon garden farmers used on average 99714 kg cowdung, 521 kg TSP, 743 kg MoP, and 728 kg urea per hectare. In (6–10)th year lemon garden farmers used on average 91650 kg cowdung, 520 kg TSP, 710 kg MoP, and 635 kg Urea per hectare. In 11–15 year lemon garden farmers used on average 70960 kg cowdung, 443 kg TSP, 640 kg MoP, and 577 kg Urea per hectare. Farmers apply different insecticides and pesticides on the basis of respective disease symptom their garden. It was observed that Farmer used bamboo as a pillar/ support to protect the tree (Table 7).

Table 7. Per hectare input used for Colombo lemon cultivation in the Narsingdi area

Parameters	Period of cultivation (year)						
	1st	2	3	4	5	6–10	11–15
Sample number							
Human labour (man-days)	383	350	361	410	415	349	327
Family labour (man-days)	127	110	124	144	138	103	154
Hired labour (man-days)	256	240	237	266	277	246	173
Seed(sapling)	988	956	904	896	864	832	789
Cow dung(kg)	79040	90650	92648	108460	99714	91650	70960
Urea (kg)	800	726	849	771	728	635	577
TSP (kg)	741	557	509	521	521	520	443
MP (kg)	787	605	639	784	743	710	640
Bamboo (tk.)	-	956	1804	2450	2560	3253	3156

Source: Field survey, 2016.

Cost of Production: Cost of production included human labour, seedling/saplings, manures, fertilizers, pesticides, land development, irrigation and pillar/support, etc. Rental value of land was treated as fixed cost and shown in total costs. Land development and saplings cost was

involved only during first year. Highest cost was estimated Tk. 316505/ha in the 4th year garden and the lowest cost was observed Tk. 257543/ha in 11-15th year garden. Among the cost items Colombo lemon

Table 8. Per hectare cost of Colombo lemon cultivation in the Narsingdi area (in Tk./ha)

Parameters (Tk./ha.)	Period of cultivation(year)						
	1	2	3	4	5	6–10	11–15
Sample size (No.)	8	8	8	8	8	10	10
Human labour	115000	105000	108569	123015	124535	104850	98257
saplings	29640	-	-	-	-	-	-
Cowdung	39520	45325	46324	54230	49857	45825	35480
Fertilizers							
Urea	16005	14536	16985	15420	14568	12560	11542
TSP	19266	14500	13254	13560	13548	13536	12360
MP	12597	9682	10234	12547	11895	11365	10254
Insecticides	11200	12546	9875	10254	8965	8964	9857
Pesticides	2300	3650	3650	5478	6548	7850	7890
Irrigation	12350	12840	12480	12479	12589	16254	14582
Pillar/support	-	19760	14256	19825	23254	12548	11365
Interest on opt. capital (8%)	20630.24	17446	17709	19758	19400	17696	16017
Rental value of land	29939	29939	29939	29939	29939	29939	29939
Total cost (Tk.)	308447	285224	283275	316505	315098	281387	257543

Source: Field survey, 2016.

cultivation human labour incurred the highest cost and second highest cost was found in cowdung and fertilizer application (Table 8).

Yield and Gross Return: After one year of seedlings/saplings Colombo lemon production start and continue ten to fifteen years old tree. Yield was increasing from

2nd year to 5th year garden and it declined thereafter. Price was varying quality of lemon and season to season. Last year farmer got average price Tk.50 per kg. The average highest yield was found 16830 kg/ha at 5th year garden and lowest yield 8272 piece/ha at (11–15)th year garden.

Table 9. Profitability of Colombo lemon in the Narsingdi area

Item	Period of cultivation(year)						
	1	2	3	4	5	10–14	15–20
Sample size	8	8	8	8	8	10	10
Yield (kg/ha)	0	12970	13638	15707	16830	10275	8272
Unit price (kg)	-	50	50	50	50	50	50
Gross return (Tk./ha)	0	648500	681900	785350	841500	513750	413600
T. variable cost (Tk./ha)	257878	237839	235627	266808	265759	233752	211587
Gross margin	-257878	410661	446273	518542	575741	279998	202013
Total cost (Tk./ha)	308447	285224	283275	316505	315098	281387	257543
Net return (Tk./ha)	-308447	363276	398625	468845	526402	232363	156057
Benefit Cost Ratio(BCR)	-	2.27	2.40	2.48	2.67	1.82	1.61

Source: Authors' calculation based on field survey, 2016.

The highest gross return was found in Tk. 841524 for 5th years garden and lowest return was Tk. 413616 in 11–15th years gardens. Highest gross margin was found Tk.556365 per hectare at 5th year garden and lowest in (11–15)th year Tk. 257543 per hectare. Net return was negative in 1st year and highest net return was found Tk. 526462 per hectare at 5th year and lowest in (11–15)th year garden Tk. 156073 per hectare (Table 9).

BCR, NPV and IRR

Discounting is a technique that converts all benefits and costs into their value in the present. The rate at which a future value is discounted is closely related to the rate at which present values are compounded, namely interest

rate whenever the benefits and costs used in a benefit-cost analysis occur in the future, it is important to discount these future values to account for their present value. To calculate benefit-cost ratio (BCR), net present worth (NPV) and internal rate of return (IRR) the cost and returns was discounted at 6.5% rate of interest.

Benefit cost ratio for Colombo lemon in Narsingdi area 1.81, which is greater than one, it means Colombo lemon gardening is profitable. Net present value was Tk. 2157561/ha which also indicated profitability of Colombo lemon garden. Internal rate of return was found 65%, indicated the IRR greater than the discount rate for a project to be accepted (Table 10).

Table 10. Summary of original BCR, NPV, IRR and sensitivity analysis for Colombo lemon

Lemon	location	Criteria	BCR at 6.5%	NPV at 6.5%	IRR at 6.5%
Colombo	Narsingdi	Original	1.81	2157561	65
lemon		10% decrease in return	1.62	1674054	57
		10% increase in cost	1.64	1889810	60

Source: Authors' estimation based on field survey, 2016.

Sensitivity Analysis: To make a valid generalization it is necessary to conduct sensitivity analysis. By doing sensitivity analysis under different conditions know that what happens profitability of Colombo lemon. It was observed from table that BCR was greater than one. NPV was positive at 6.5% discount rate and IRR was also higher than the opportunity cost of capital. This implies that if the returns decrease at 10% or total cost increases at 10%, the owner of Colombo lemon can make profit. Analyzed result show that Colombo lemon growers can earn profits under changing situation.

Constraints of Jara and Colombo lemon: The farmers in the study areas encountered various constraints during

production of Jara and Colombo lemon. All these constraints were ranked according to the frequencies of responses. It was found that 62% farmers have poor knowledge about improved production technology for growing lemon. Due to lack of modern technical knowledge farmers were using traditional method of cultivation and getting low yield. On average 70% farmers reported that non availability of quality seedlings/saplings at farm level. Acute problem in insect/pest infestation like cancer, Gummosis, Butterfly were found different garden. About 54% farmers opined that non availability of good quality insecticides and fertilizers their production hampered. About 80% growers claimed that lack of cash money as the major

problem for initial establishment of lemon garden. About 45% farmers claimed lack of supervision at field level by research and extension personnel farmers opined that they can not produce export quality lemon.

Hundred percent farmers mentioned that because of few numbers of export buyers they did not get fair price (Table 11).

Table 11. Constraints of Jara and Colombo lemon at farmers' level

Constraints	Jara and Colombo
Particulars	% of respondent
Limited number of buyer	100
Difficulties to maintain export quality	90
Lack of modern technical knowledge	62
Non availability of quality saplings	70
Insect/pest infestation	54
Lack of capital for initial investment	80
Not getting proper suggestion	45

Source: Authors' estimation based on field survey, 2016.

Conclusions and Recommendations

From this study it is clear understanding the present situation of production of Jara and Colombo lemon. Farmers established their garden to produce export quality lemon. Agronomic practices were found more or less similar in both lemon. Farmers used grafting saplings, planting time from June to August, average plant to plant distance 3 meters. Farmers apply cowdung, Urea, TSP and MoP at their garden. Main cost items were found labour and fertilizer application. The benefit cost ratio, net present value and internal rate of return indicate that farmers were benefited to cultivation Jara and Colombo lemon in the study areas. By doing sensitivity analysis it is clear that both lemon producers can earn profit under changing situation.

Although Jara and Colombo lemon are grown in Bangladesh for a long time, very little attention has been given to its increased production and export. Most of the farmers cultivate traditional method. Based on the following recommendations were put forward to increase the production of Jara and Colombo lemon. BARI should developed improved varieties of Jara and Colombo lemon, location specific production technology and government should take initiatives to disseminate to the farmers since it's a profitable business for the respective farmers'. Regular Training should be

arranged to the farmers to develop their knowledge about improved cultivation practices of Jara and Colombo lemon. Government should take initiative to motivate the farmers to cultivate and adopted new technology of Jara and Colombo lemon for ensuring better livelihood standards.

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