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PROFITABILITY ANALYSIS OF PAPAYA CULTIVATION IN SOME SELECTED AREAS OF BANGLADESH

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Abstract

The study was conducted to depict the overall economics of papaya cultivation in four districts namely Tangail, Jashore, Bandarban and Rajshahi. The objectives of the study were to examine the cost structure, resource use productivities, profitability and the problems of papaya production. A total of 152 farmers taking 38 from each district were selected randomly. Data were collected through a pre-tested interview schedule during January-March, 2017. The per hectare use of human labour, plant protection, manures and fertilizer were found to be maximum at Jashore whereas, the per hectare use of saplings was found to be maximum at Tangail district. The per hectare cost of cultivation of papaya was high at Jossere (365405) followed by Tangail (Tk.334261), Rajshahi (Tk.319754), and Bandarban (Tk. 272664). The average per hectare yield were maximum at Jossere (62MT) followed by Rajshahi (55MT), Tangail (54MT) and Bandarban (52MT). Per hectare gross margin was the highest at Tangail (Tk. 802797) followed by Bandarban (Tk. 658441), Jashore (Tk. 536346) and Rajshahi (Tk.471298). Per hectare net return was highest at Tangail (Tk.633738) followed by Bandarban (Tk.507335), Jossere (Tk.346594) and Rajshahi (Tk.302747). The overall benefit cost ratio was 2.39 which indicates papaya cultivation was profitable in Bangladesh. The yield of papaya would increase by 0.0407, 0.125, 00.0627, 0.0863 and 0.3785 % if papaya farmers apply 1% additional human labour, seedlings/saplings, fertilizer, improved variety, and dummy for loamy soil. Attacks on viral disease, adverse weather condition, non-availability of reliable seed, lack of irrigation facilities, lack of technical knowledge and problems in marketing of papaya were the major constraints of papaya cultivation in the study areas.

1. Introduction

Agriculture is the most dominant sector of the national economy of Bangladesh contributing nearly 17%of national income. On the other hand, about 45% of the population depends for their subsistence and livelihood on the agriculture sector (BBS, 2016). A number of crops are being cultivated in different parts of the country due to varying agro-climatic conditions. Among various fruits, papaya is

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one of the important fruits which is cultivated all over the country. The plants are of medium height (180-220 cm) and fruits are of medium to large size (1-2 kg) (BARI, 2014). The taste is superb with excellent quality. The ripe fresh fruits of papaya are eaten throughout the tropics, while unripe fruits are commonly used as vegetables for cooking. Every 100 gms of papaya contains 2020 I.U. vitamin A, 40 mg vitamin C, 10 mg calcium, 10 mgphosphorus, 9.5 gms of carbohydrates, and 0.5 gms of proteins (Sharma and Singh, 1990).

Papaya is a crop which has versatile uses. Raw papayas can be used for making salted pickles, while fully developed but somewhat raw fruits are used to make a perfect jelly, jam, candy, nectar, puree, concentrate, slab, powder, toffee, tutti-frutti, freeze dried chunks, dried rolls, dried slices are some other products that are made from papaya fruit (Garde, 1997). Now a days papain extraction from unripe fruits of papaya is one of the most important use. Papain is the dried latex from the fruit, containing a protein hydrolyzing enzyme which has a number of specific technological functions *viz.*, food and beverage preparations, pharmaceutical applications, textile industries and garment cleaning (Kumar and Saha, 1997).

Although climatic conditions of Bangladesh topapaya production. It is cultivated on large scale in Jashore, Rajshahi, Kustia, Tangail, Khulna and hill tracts. The national production of papaya is 332093 metric tons with an area of 14547 acres in 2015-2016 (BBS, 2016).

Table 1. Area and production of papaya at different years

year	Green papaya		Ripe papaya	
	Area(Acres)	Production(M. tons)	Area(Acres)	Production(M. tons)
2013-14	3973	207244	3021	130596
2014-15	5690	198724	3126	133370
2015-16	4786	201722	9761	130371

Source: Yearbook of Agricultural Statistics, 2016.

A good number of papaya varieties grown in Bangladesh such as Red lady, Top lady, Coorg honeydew, Washington, Ranchi, Shahi Papaya Kashimpur, and some exotic varieties. Papaya being a high value crop has got tremendous scope to increase the income of farmers with its high yield potential .Since no serious attempts have been found to know, a large number of farmers throughout the country are still unwilling to cultivate improved papaya varieties. It is important to know the farm level adoption of different varieties, their costs, returns, profitability, per hectare yield, per metric ton cost of production, and constraints faced by growers. Keeping all this points in mind the present study was under taken with following specific Objectives:

- To know the cultivation practices of papaya in different locations
- To estimate the profitability of papaya cultivation;

- To examine the resource use efficiency by using Cobb-Douglas production function;
- To identify constraints and problems of papaya production and to suggest appropriate policy measures.

2. Methodology

2.1 Sampling procedure and sample size

The study was conducted in four districts of Bangladesh namely Tangail, Jashore, Bandarban and Rajshahi. Then one upazila from each district and two blocks from each upazila were purposively selected in consultation with DAE personnel and papaya scientists. Finally, a total of 160 farmers, taking 40 from each district were randomly selected for the study (Table 2).

Table 2. Study areas and respondent farmers

Sl. No.	Name of district	Name of upazila	Name ofagril. block	No. of farmer
1	Tangail	Madhupur	Magandinagar	20
			Orunkhula	20
2	Jossere	Jhikargacha	Godkhali	20
			Horinagar	20
3	Bandarban	Bandarbansadar	Tumcopara	20
			kuhalong	20
4	Rajshahi	Paba	Parila	20
			hargram	20
Total				160

2.2 Data collection

The primary data like farm family, infrastructure, land utilization, cropping pattern, input use, farm production, papaya grading, packaging and transport in marketing cost, and problems of cultivation and marketing of papaya were collected by personal interview with the sample respondents. The data related to the year 2016-2017 were collected by survey method with the help of a pre specially designed comprehensive and pre-tested interview schedule.

2.3 Analytical techniques

Collected data were edited, summarized, tabulated and analyzed to fulfill the objectives of the study. Descriptive statistics using different statistical tolls like averages, percentages and ratios were used for presentation of the results of the study. The profitability of papaya production was examined on the basis of gross return, gross margin and benefit cost ratio analysis (Boardma, 1996). Besides, the

opportunity costs of family supplied labour were taken into consideration in estimating total cost. Land use cost was calculated on the basis of per year lease value of land.

2.3.1 Profitability analysis

The following equations were used to estimate the profitability of papaya cultivation at farm level.

Equations for cost analysis:

$$\text{Variable cost} = \sum_{I=1}^{n}(xijpij)$$

$$TVCij = VCij + IOCij$$

$$TCij = TVCij + TFCij$$

Where, TCij = Total cost of jth crop for ith farmer (Tk/ha)

TVCij = Total variable cost of j^{th}crop for i^{th} farmer (Tk/ha).

TFCij = Total fixed cost of j^{th}crop for i^{th} farmer (Tk/ha)

VCij = Variable cost of j^{th} crop for i^{th} farmer (Tk/ha)

IOCij = Interest of operating capital of j^{th} crop for i^{th} farmer (Tk/ha)

Xij = Quantity of inputs of j^{th} crop for i^{th} farmer (kg)

Pij = Price of inputs of j^{th} crop for i^{th} farmer (Tk/kg)

J = Number of crops

i = Number of farmers (1.2.3 ……..n)

Equations for profitability analysis

Gross return = GRij = YijPij

Net return = GRij – TCij

Gross margin = GRij – VCij

Where,

GRij = Gross return of j^{th} crop for i^{th} farmer (Tk/ha)

Pij = Price (Tk/ha) of j^{th} crops received by i^{th} farmer

Yij = Quantity (kg/ha) produced of j^{th} crop for i^{th} farmer.

2.3.2 Choice of function

The empirical evidences form the previous studies suggested that to study the relationship between crop output and input variables, the following Cobb-Douglas production function was used.

$$Y = a\, X_1^{b1}.X_2^{b2}…….X_n^{bn}\, .e^{\mu}$$

In the logarithmic transformation, the function becomes linear one. This function allows constant, increasing or decreasing return to scale. In this function 'b_1' is the elasticity of production of factor X_1, and can be used directly irrespective of units of measurement. The function in logarithmic form is expressed as follows.

$$\text{Log } Y = \text{Log } a + b_1 \text{ Log } X_1 + b_2 \text{ Log } X_2 + ... + b_n \text{ Log } X_n + \mu \text{ Log } e$$

2.3.4 Selection of variables

Nine independent variables were considered as important contributors to the production of papaya. The equation fitted was of the following form (Kapase, 1992).

$$Y = a.\ X_1^{b1}\ X_2^{b2}\ X_3^{b3}\ X_4^{b4}\ X_5^{b5}\ X_6^{b6}\ X_7^{b7} X_8^{b8}\ X_9^{b9}\ e^{\mu}$$

i.e. $\text{LogY} = \log a + b_1 \log X_1 + b_2 \log X_2 + b_4 \log X_4 + b_3 \log X_3 + b_5 \log X_5 +$

$b_6 \log X_6 + b_7 \log X_7 + b_8 \log X_8 + b_9 \log X_9 + \mu \log e$

where,

i) Dependent variable

Y = Yield of papaya (MT/ha)

ii) Independent variable

X_1 = Land preparation cost (Tk./ha)
X_2 = Quantity of fertilizer (kg)
X_3 = Quantity of manures (kg)
X_4 = Total human labour (in man days)
X_5= Seedlings/saplings cost (Tk/ha)
X_6 = Expenditure on plant protection (Tk./ha)
X_7= Irrigation (No.)
X_8= Dummy for soil type(1= Loam, 0= otherwise
X_9= Dummy for papaya variety (1= improved, 0= otherwise)
a = Intercept term (constant)
bi = Regression coefficient or elasticity of production (1 = 1, .. .9)
e^{μ}= Error term
The estimated production function was statistically tested with the help of 't' test and 'F' value.

3. Results and Discussion

3.1 Production practices of papaya at different location

Papaya farmers in the study areas used different types of varieties such shahi papaya, red lady, top lady, Indian and different local varieties. On an average 28% farmers used local variety. Among different locations 45% farmers in Tangail districts used local variety because farmers established their garden in pineapple orchard. The maximum (60%) gardens were established on plain land

in all areas which was 78% farmers choose sandy loamy soil for papaya cultivation. Planting was done during monsoon season in the study area. Papayas are planted in pits of 50 cm x 50 cm x 50 cm size in a square system with spacing of 2 m x 2m accommodating 10442 plants/ha. Before planting, the farmers filled pits with 10-15 kg decomposed farm yard manure that mixed with surface soil. In the study area the sample farmers irrigated 7-8 times in their papaya garden. The responded papaya growers mainly cultivated ginger, turmeric, pineapple, banana, chili and different leguminous crop as inter crops.

Table 3. Cultivation practices of papaya in farmers field at different locations

Production practice	Locations				
	Tangail	Jossere	Bandarban	Rajshahi	All areas
1.Varity used (% of farmers)					
Local variety	45	30	24	16	28
Shahi papaya	18	26	15	58	29
Red lady	10	18	30	12	18
Top lady	7	9	8	5	7
Others hybrid	20	17	23	7	17
2. Types of land: (%)High land					
Medium high land	50	20	60	30	40
Plain land	50	80	40	70	60
3. Types of soil: (%)					
Sandy soil					
Loamy soil	30	20		40	22
Sandy loamy soil	70	80	100	60	78
4. Sources of seedling: (%)					
Own garden	30	30		35	24
Market/neighbor	70	60	50	65	61
BADC/Others		10	50		15
5. Planting time	March-April	March-April	March-April	March-April	March-April
6. No. of saplings /ha	10560	10860	10000	10350	10442
7. Age of saplings (days)	40-60	40-60	40-60	40-60	40-60
8.Plant to plant distance(meters)	1.8	1.7	2.3	1.9	1.93
9.Depth of pit (c.m.)	45	45	45	45	45
10. Weeding (No./year)	10	12	8	10	10
11. Spraying (times)	2.5	3.6	1.8	3.4	2.8
12. Irrigation (No./year)	8	8.5	5.3	9.5	7.8
Intercrop and relay crop	Ginger, turmeric, pineapple, banana	Brinjal, chilli	Ginger, turmeric Banana, chilli	Chilli, brinjal, Banana pulse	Ginger, turmeric, pineapple, banana, chilli

Source: Field survey, 2017.

3.2 Input Utilization

Uses of various inputs directly affect the cost of cultivation. Papaya farmers use different inputs like human labour, machinery, seeds, saplings, manures, fertilizers, irrigation, plant protection etc. in their garden. The information regarding per hectare inputs utilization for papaya cultivation of selected farms of different size groups is presented in Table 4.

Table 4. Input use pattern per hectare for papaya cultivation.

Particulars	Units	Actual utilization level on different locations				
		Tangail	Jossere	Bandarban	Rajshahi	All areas
Human labour	man days	185	204	162	187	184
Family labour		105	120	100	80	101
Hired labour		80	84	62	107	83
Power tiller cost	Tk.	6000	6526	5580	6850	6239
Manures	kg	45000	65504	23309	57046	47714
Fertilizers						
Urea	kg	1470	1560	705	1091	1207
MoP	kg	980	780	650	830	810
TSP	kg	1210	1380	1210	1208	1252
Gypsum	kg	750	812	713	755	757
Boric acid	kg	96	105	92	85	94
Zinc sulfate	kg	74	82	86	88	83
Irrigation	No.	8	8.5	5.3	9.5	7.8
Plant protection cost	Tk.	6362	6820	6750	6138	6517

Source: Field survey, 2017.

Fertilizers should be applied in time to achieve good yield. The doses of fertilizers should be applied depending on the variety and initial soil fertility. Urea (450-500) gm and MP (450-500) gm per plant should be applied as split application. Urea (50gm) and MP (50gm) should be applied per plant one month interval commencing from one month after plant. The fertilizer doses should be double after flowering. The average quantity of manures applied by the farmers was worked out as 47714 kg per hectare. Human labour was required for land development, plantation of sapling, application of manures and fertilizers, spraying, weeding, irrigation and harvesting. On an average, 184 man-days of human labour was required for papaya cultivation of which 55% was family supplied and 45% was hired labour. The average application of fertilizers per hectare in terms of urea1207kg, MoP 810 kg, TSP 1252 kg, gypsum 757 kg, boric acid 94kg and zinc sulfate 83kg were applied. The average number of irrigation was 7.8 per hectare. The number of irrigation in case of Tangail, Jashore, Bandarban and Rajshahi were 8, 8.5, 5.3 and 9.5 in numbers, respectively. Plant protection in monetary terms was Tk.6517, while it was the highest at Jashore (Tk. 6820)and the lowest at Rajshahi (Tk. 6138).

3.3 Cost of cultivation

Planting materials, land preparation, input cost (FYM, fertilizers, plant growth regulators, plant protection chemicals etc.), labour cost, power cost, harvesting, packing and transportation charges were the cost components for papaya cultivation. Rental value of land was treated as fixed cost and interest on operating capital was also considered for the estimation of papaya cultivation cost. On average farmers spend Tk. 6239/ha for land preparation by using power tiller/tractor. The highest manures cost was observed Tk. 49128/ha at Jashore followed by Rajshahi (Tk. 42784/ha), Tangail (Tk. 33750/ha) and Bandarban (Tk. 23309/ha). Per hectare average saplings cost was Tk.31327 which was the highest in Jashore (Tk.32580) and lowest in Bandarban (Tk3000).Among variable costs human labour cost was the highest in all study areas. The highest human labour cost was observed (Tk. 57120/ha) at Jashore and lowest (Tk. 40500/ha) in Bandarban. The overall rental value of land was Tk.30374/ha. The interest on fixed cost and interest on operating cost was calculated @ of 8% basis. Among four locations the highest total cost was found Tk. 365405/ha at Jashore and lowest inBandarbanTk.272664/ha.

Table 5. Per hectare cost of cultivation of papaya in different locations

Cost heading	Tangail	Jossere	Bandarban	Rajshahi	All areas	% of total cost
Land preparation	6000	6526	5580	6850	6239	1.93
Manures	33750	49128	23309	42784	37242	11.53
Human labour*	51800	57120	40500	48620	49509	15.33
TSP	30250	34500	30250	30210	31302	9.69
Gypsum	9000	9744	8556	9060	9090	2.81
Saplings	31680	32580	30000	31050	31327	9.70
Urea	23520	24960	11280	17456	19304	5.98
Mop	16660	13260	11050	14110	13770	4.26
Boric acid	17280	18900	16560	15300	17010	5.27
Zinc sulfate	13320	14760	15480	15840	14850	4.59
Irrigation	10956	10620	8360	10311	10061	3.11
Plant protection cost	6362	6820	6750	6138	6517	2.02
Bamboo and fencing	20000	24000	14652	17920	19143	5.93
Transportation	2300	2420	2140	2360	2305	0.71
Miscellaneous expense	3623	3000	3000	3560	3295	1.02
Interest on operating capital	22120	24667	18197	21725	21677	6.72
Rental value of land	35639	32399	26999	26460	30374	9.40
Total cost	334261	365405	272664	319755	323018	100

*Human labour cost included expenditure on land development, farm layout, digging of pits, filling of pits and application of inputs.

3.4 Profitability of papaya cultivation

Input-output ratio indicates the rate at which the expenses on different inputs and factors are paid for. It also indicates the degree of profitability in relation to expenditure. The output input relationship worked out at the different cost concepts indicates the ratio between the gross income and cost showing the returns per taka invested. The output-input ratio in papaya cultivation in different locations is shown in the table 6. After 3-5 months of garden age, papaya production started and its continue up to twelve months. Farmers marked two categories of papaya such as green papaya as vegetables and ripe papaya as fruit. Prices of both categories depend on quality and seasonality of production. In the last year farmers got the average price of green papaya Tk. 8.87 per kg and ripe papaya tk. 19.5 per kg. Per hectare highest yield was found 60MT at Jossere followed by Rajshahi (55MT), Tangail (54MT) and Bandarban (52MT). The highest gross return was estimated at Tk. 968000 for Tangail followed by Bandarban (Tk. 780000), Jashore (Tk. 712000) and Rajshahi (Tk. 622500). Average gross margin was estimated Tk.622500. Net return was highest Tk. 633738 at Tangail followed by Bandarban (Tk.507335), Jashore (Tk.346594) and Rajshahi (Tk.302745). Average BCR was 2.39 which was than one meaning that papaya cultivation was a profitable farm business at farmers' level in the study areas (Table 6).

Table 6. Yield level, farm harvest price and gross income per hectare at different locations

Locations	Yield (green papaya) MT/ha	Yield (ripe papaya) MT/ha	Harvest price (green) Tk./MT	Harvest price (ripe) Tk/MT	Gross output (Tk./ha)
Tangail	20	34	11000	22000	968000
Jashore	35	27	8000	16000	712000
Bandarban	28	24	9000	22000	780000
Rajshahi	35	20	7500	18000	622500
All areas	29.5	26.25	8875	19500	773688.5

Source: Field survey, 2017.

3.5 Factors affecting papaya production

Papaya production at farm level is influenced by different variables. The estimates of the parameters of the Cobb-Douglas production function for papaya are presented in Table 7. The coefficients of the variables in the function are the elasticity of average output with respect to the different inputs used in papaya production.

Table 7. Profitability analysis of papaya cultivation at different locations

Items	Locations				
	Tangail	Jessore	Bandarban	Rajshahi	All areas
A. Total cost (TC)	334261	365405	272664	319754	323018
b. Total variable cost (TVC)	165202	175653	121558	151202	153401
Gross return(Tk./ha)	968000	712000	780000	622500	773687
Gross margin(Tk./ha)	802797	536346	658441	471298	620286
Net return(Tk./ha)	633738	346594	507335	302745	450668
BCR(cash cost basis)	5.86	4.05	6.42	4.12	5.04
BCR (Full cost basis)	2.89	1.95	2.86	1.94	2.39

Table 8. Regression coefficient and coefficient of multiple determinations for papaya

Variables	Locations				
	Tangail	Jossere	Bandarban	Rajshahi	All areas
Constant	3.43	4.34	5.68	3.23	3.36
Land preparation cost (Tk.)	0.0231	0.0265	0.0023	0.0365	0.0298
Fertilizer(kg)	0.0326*	0.0112**	0.0134*	0.0637**	0.0627**
Manures (kg)	0.0365	0.0277	0.02568	0.0586	0.0624
Human labour (days)	0.0425**	0.0301**	0.02365**	0.0389**	0.0407**
Seedlings/saplings cost (Tk)	0.0236*	0.1861*	0.0365*	0.0129*	0.125*
Plant protection chemicals (Tk)	0.06325	0.0925	0.0864	0.0962	0.0913
Irrigation (No.)	0.0362	0.3730	0.7802**	0.7562**	0.0213
Dummy for soil type (1= Loam, 0= otherwise	0.0985*	0.0785*	0.0986*	0.8752*	0.0863*
Dummy for papaya variety (1= improved, 0= otherwise)	0.8562***	0.965***	0.3562***	0.3689***	0.3785***
R^2	75	84	82	79	82
F value	89	91	84	95	93

The empirical results indicated that the coefficients of human labour, seedlings, fertilizer, papaya variety, and soil type had positive and significant impacts on papaya production at farm level. The yield of papaya would increase by 0.0407, 0.125, 0.0627, 0.0863 and 0.3785% if papaya farmers use 1% additional human labour, seedlings/saplings, fertilizer, papaya variety, and loamy soil. More or less similar results regarding significant variables were found in the Cobb-Douglas production function models estimated of papaya production in the study areas.

Table 9. Constraints faced by farmers at different locations

Constraints	% farmers responded				
	Tangail	Jossere	Bandarban	Rajshahi	All areas
Do not protected crop from adverse weather	80	85	86	85	84.0
No proper control for viral disease	70	90	89	85	83.5
Do not know the name, proper method and doses of pesticides and insecticides	70	75	85	76	76.5
Problems in marketing of papaya	60	80	60	85	71.3
No direction and encouragement from local administration for papaya cultivation	60	63	72	50	61.3
Non availability of quality seedling	60	50	60	55	56.3
Lack of capital	50	45	80	50	56.3
Do not know the name and proper doses of manures and fertilizers	50	60	72	40	55.5
Non-availability of institutional loan	50	56	62	40	52.0
Lack of irrigation facilities	40	30	70	65	51.3
Lack of technical know-how for papaya cultivation	45	40	70	42	49.3
Problems of intercultural operations	30	35	26	28	29.8

Source: Field survey, 2017

3.6 Constraints to cultivation of papaya

The constraints relating to different resources reported by the sample farmers in the production of papaya are depicted in Table 8. It is observed that 56%sample farmers did not get reliable quality seedlings in time while, 83% of the sample farmers reported to non-availability of viral disease resistant seed to which was very dreadful to crop. Forty nine per cent of selected farmers complained about lack of knowledge about production technology. Non- availability of pesticides on time and lack of knowledge about its use were opined by 76% sample growers, while 55% stated that they did not know the name and proper doses of manures and fertilizers. Papaya growing is capital intensive enterprise that why 56% of sample farmers complained about inadequate capital. Eighty four per cent of the sample farmers reported that they could protect their garden from adverse weather condition and 71% farmers claimed that marketing of papaya was a serious problem. Farmers did not get proper price when peak period. Irrigation facilities were not adequate in the study areas mentioned by 51% farmers as a problem.

4. Conclusions and Recommendations

4.1 Conclusions

The study was conducted for understanding the present situation of papaya cultivation in Bangladesh. This study examined the production practices of papaya at different locations. It also gives clear picture of papaya cultivation in hill regions and plain land. Highest cost item was found human labour cost followed by fertilizer cost and saplings cost. Mostly family labour was used for papaya cultivation. The gross margin, net margin and benefit cost ratio indicated that farmers were benefited from cultivation of papaya in all areas. Human labour, seedlings, fertilizer, improved papaya variety, and loamy soil had positive and significant impacts on papaya production at farm level. In production of papaya, growers faced the problems of non-availability and high prices of quality seedlings, shortage of labour and no proper control over viral disease. While low price of papaya, fluctuating prices, higher transportation cost etc. were reported to be major problems of papaya cultivation in the study areas.

4.2 Recommendations

- Papaya growers cultivate exotic varieties which are much susceptible to virus diseases so farmers need suitable high yielding and virus resistant variety of papaya.
- Regular training should be arranged for the farmers to developing their knowledge about improved cultivation practices and adaptation of new technology.
- Fertilizers and plant protection chemicals price should be reduced.

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