

PRODUCTIVITY MEASUREMENT OF SELECTED SUGAR MILLS IN BANGLADESH

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Abstract

Sugar industry plays significant role in the economy of Bangladesh. This industry saves country's hard-earning foreign currency, develop rural infrastructure of Bangladesh and increases the income of the farmers. Productivity measures the utilization of production capacity of an industry. In this study, value of sugar production acts as dependent variable and partial productivity such as cost of material productivity, wages & salaries productivity, energy productivity, overhead productivity, machine productivity, fixed assets productivity, current assets productivity, capital employed productivity etc. are taken as independent variables. In case of physical output, only quantity of sugar production is treated as dependent variable and machine productivity and recovery rate are used as independent variable. Different partial productivity of the selected sugar factories are decreasing year after year. Without sufficient supply of quality sugarcane the mills will collapse very soon. The government should take a pragmatic decision in regard to feeding the power produced by the sugar factories to the national grids.

Keywords: Sugarcane, Sugar production, Productivity, Correlation

Introduction

With the utilization of productivity index for investigating a firm's performance makes it possible to evaluate efficiency of the production system and cost at the same time. Improvement of science and technology, Identification of production resources along with proper utilization of those resources should be considered as one of the essential factors for achieving success in economic development. Economic growth requires increase in production and production growth is possible either using more production factors or use of improved technology along with more efficient utilization of production factors.

Saha (1989) observed that the performance of the sugar industry in Bangladesh is affected by some controllable and uncontrollable factors. The main problems of sugar industry are non-availability of sugarcane due to diversion of sugarcane into gur production, low sucrose recovery rates, increasing cost of production and absence of modernization of plant etc.

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Akkas (1989) conducted a study on performance of sugar industry of Bangladesh and he observed that the performance varied from year to year due to difference in supply of sugarcane to sugar mills, recovery rate of sugar, climatic conditions, pricing policies of sugarcane and fluctuation of cost of production.

Moniruzzaman (2002) reported that, Productivity performance: A Comparative Study of the Public and Private Sector Textile Units in Bangladesh. He had identified that productivity is the effective and efficient use of inputs of different types, viz. capital physical resources, labor, machinery, knowledge and the like. He also found out the factors that affected the productivity were lack of capital, power failure, and old machinery, poor maintains, poor quality of raw materials, poor labor management relationship, congenial working conditions, and recognition of government policy, awareness and commitment.

Sabur (2007) carried out an important study on “Relative Production Efficiency of Sugar Mills in Bangladesh”. The study measured the relative efficiencies of individual small size sugar mills in Bangladesh and sets target for relatively inefficient sugar mills to improve their performance. The objective of the study was to introduce the technique and demonstrate it through an example to show how relative efficiencies can be determined and identify units that were relatively less efficient. They show that seasonal labor hours and crushing hours, both the inputs, were found to be highly underutilized in almost all inefficient sugar mills.

The objectives of the study are stated below: (i) To measure the productivity position of sugar factory from 2007 to 2011, (ii) To find whether there is significant variance in productivity among small sized sugar mills during the study period, (iii) To find whether there is significant variance in productivity among large sized sugar mills during the study period, (iv) To find out the influencing factors of productivity measurement, (v) To give suggestions for better productivity in case of sugar industry.

Materials and Methods

The present study covers six selected sugar mills of Bangladesh. These sugar mills are selected purposely taking three from large-sized sugar mills and three from small-sized sugar mills. The secondary data are collected from annual performance reports published by individual sugar mill as well as BSFIC. This study covers five years period from 2007 to 2011. In this context, arithmetic mean, exponential growth rate, ANOVA etc. are used to make the article easier and more understanding.

Hypotheses of the study

Null hypotheses are assumed as follows:

1. There is no significant variation in productivity among the large-sized selected sugar mills during the study period.

2. There is no significant variation in productivity among the selected small-sized selected sugar mills during the study period.
3. There is no significant correlation of physical sugar production with recovery rate and machine productivity.

Concept of Productivity Measurement

According to APO, productivity refers to a comparison between the goods and services produced on the resources employed in the production process⁶. There are three basic concepts which are interrelated and need to manage carefully by sugar industry are:

- i) Production.
- ii) Productivity, and
- iii) Cost effectiveness.

Production is the process of transforming sugarcane into sugar for sale. Production function specifies a flow of output resulting from a flow of inputs during a specified period of time⁷.

Productivity is the quality that indicates how well labor, materials, capital and energy are utilized in production process. Higher productivity enhances the national wealth and per capita income which in turn increases the purchasing power of taka. Productivity is the ratio of wealth produced and input of resources used in the process of production.

Cost effectiveness implies the capacity of factories to produce sugar at a lower cost through more effective utilization of all inputs (material, capital, plant and machinery, labor and energy etc.). It is the process of cost reduction by improving efficiency of operations.

Measure of Output

In the measurement of output, value of production is taken as output. Value of output is the aggregate value of sugar production multiplied by government fixed selling price rate plus the actual income from selling of molasses and actual other income from other by-products.

Table 1. Kushtia Sugar Mills Ltd.

	2007	2008	2009	2010	2011	Avg.	EGR
Materials productivity	1.79	1.79	1.74	1.50	1.42	1.65	-4.61
Wages & salaries productivity	3.39	3.19	1.64	0.67	1.16	2.01	-21.44
Energy cost productivity	18.54	17.63	13.51	8.63	12.74	14.21	-7.52
Overheads cost productivity	11.36	10.75	6.73	3.23	6.73	7.76	-10.48
Overall cost productivity	1.00	0.98	0.71	0.39	0.56	0.73	-11.76
Machine productivity	1.39	1.48	1.46	1.24	1.51	1.42	1.67
Fixed assets productivity	13.13	10.78	6.54	3.16	8.18	8.36	-9.45
Current assets productivity	1.03	1.54	0.87	0.32	0.64	0.88	-9.42
Capital employed productivity	0.96	1.35	0.77	0.29	0.60	0.79	-9.43
Cost of total input/Tk. of output	1.00	1.02	1.41	2.59	1.79	1.56	11.76
Cost of cane / Tk. of output	0.56	0.56	0.57	0.66	0.70	0.61	4.61

Source: Annual reports of relevant sugar mills.

As per Table 1 material productivity in KSM ranges from the lowest of 1.42 in 2011 to the highest of 1.79 in both in 2007 and 2008 over a period of five years. Though it seems to be 1.79 in both 2007 and 2008, it is due to low price of sugarcane and high level of sugarcane crushing. Average material productivity was 1.65 and growth rate was negative i.e., 4.61% during the period. Cost of cane to per Tk. of output was 0.56 in both 2007 and 2008 and Tk.70 in 2011 with sample average of 0.61. The EGR (exponential growth rate) was positive and adverse by 4.61 percent indicate cost of sugarcane increasing by 4.61 percent in comparing sales price of sugar.

Table 2. North Bengal Sugar Mills Ltd.

	2007	2008	2009	2010	2011	Avg.	EGR
Materials productivity	1.84	1.89	1.77	1.59	1.30	1.68	-6.99
Wages & salaries productivity	6.24	4.83	2.90	1.89	4.04	3.98	-8.70
Energy cost productivity	57.58	51.68	38.56	23.76	35.08	41.33	-9.91
Overheads cost productivity	14.06	13.93	10.58	5.52	12.55	11.33	-2.28
Overall cost productivity	1.26	1.21	0.97	0.72	0.89	1.01	-7.04
Machine productivity	2.05	2.23	2.21	2.02	2.30	2.16	2.32
Fixed assets productivity	10.51	11.73	9.56	6.72	15.10	10.72	7.24
Current assets productivity	1.09	1.19	0.72	0.40	0.84	0.85	-5.23
Capital employed productivity	0.98	1.08	0.67	0.38	0.79	0.78	-4.13
Cost of total input/Tk. of output	0.79	0.83	1.03	1.38	1.13	1.03	7.04
Cost of cane / Tk. of output	0.58	0.53	0.57	0.63	0.77	0.61	6.99

Source: Annual reports of relevant sugar mills.

Wages and salaries productivity ratios range from 0.67 in 2010 to 3.99 in 2007 while the average ratio was 2.01. EGR of the ratio was decreased by 21.44 percent during the study period due to increase in amount of wages and salaries but not increase in value of production of sugar. Energy cost productivity, overhead cost productivity and overall cost productivity show same trend like wages and salaries productivity. Cost of total input per taka of output was maximum in 2010 i.e., 2.59. Average input costs was higher than output which indicates that loss of the sugar mills without considering the bank interest and VAT.

Table 3. Pabna Sugar Mills Ltd.

	2007	2008	2009	2010	2011	Avg.	EGR
Materials productivity	6.49	6.34	4.82	5.24	3.36	5.25	-13.15
Wages & salaries productivity	15.66	15.79	5.57	4.25	5.01	9.26	-22.79
Energy cost productivity	120.23	119.94	58.77	54.94	57.03	82.18	-14.92
Overheads cost productivity	18.38	26.52	8.98	8.96	10.71	14.71	-10.80
Overall cost productivity	3.56	3.74	1.94	1.80	1.64	2.54	-15.45
Machine productivity	6.11	6.24	5.24	6.28	4.86	5.75	-4.59
Fixed assets productivity	3.55	5.40	2.03	1.73	2.47	3.04	-7.30
Current assets productivity	4.38	6.81	3.11	1.73	3.26	3.86	-5.87
Capital employed productivity	1.96	3.01	1.23	0.86	1.40	1.69	-6.67
Cost of total input/Tk. of output	0.28	0.27	0.52	0.56	0.61	0.45	15.45
Cost of cane / Tk. of output	0.15	0.16	0.21	0.19	0.30	0.20	13.15

Source: Annual reports of relevant sugar mills.

The highest machine productivity was 1.51 in 2011 and the lowest was 1.24 in 2010 with the average of 1.42 during the study period. The favorable machine productivity was increased 1.67 percent during the study period. Ratio of sugarcane cost and output of sugar is less than 1, output value still effective to cover sugarcane expense. Ratio of total input and output is more than 1, factory should efficiency one to cover all the costs of inputs.

Table 2 indicates different productivity ratios of NBSM. The highest material productivity ratio was Tk.1.89 in 2008 and the lowest for the same was Tk.1.30 in 2011 with a decrease trend by 6.99 percent during the study period. This may be due to 7.19 percent recovery rate in 2008 and 6.40 percent recovery rate in 2011. Materials productivity was decreased by 6.99 percent during the study period. Cost of wages and salaries productivity ranges from the highest of 6.99 in 2007 to lowest of 1.89 in 2010 and shows decreasing trend by 8.70 percent over a period of five years. It was found that overhead cost productivity decreased from Tk.14.06 in 2007 to Tk.5.52 in 2010. Maximum overhead cost was in 2010 and productivity decreased to the lowest of Tk.5.52 and it again increased up to 12.55 per taka of factory overhead in 2011.

Table 4. Faridpur Sugar Mills Ltd.

	2007	2008	2009	2010	2011	Avg.	EGR
Materials productivity	1.76	1.73	1.73	1.95	1.33	1.70	-5.64
Wages & salaries productivity	3.37	2.73	1.71	2.17	2.11	2.42	-9.39
Energy cost productivity	31.27	23.56	25.91	26.29	28.28	27.06	-2.01
Overheads cost productivity	12.00	10.55	8.18	10.34	10.39	10.29	-2.88
Overall cost productivity	1.02	0.92	0.76	0.90	0.74	0.87	-6.54
Machine productivity	1.24	1.37	1.87	2.02	1.98	1.70	9.44
Fixed assets productivity	12.42	11.01	8.32	10.17	10.69	10.52	-3.00
Current assets productivity	1.54	2.14	1.15	0.80	0.97	1.32	-9.30
Capital employed productivity	1.37	1.79	1.01	0.74	0.89	1.16	-8.69
Cost of total input/Tk. of output	0.98	1.08	1.32	1.11	1.36	1.17	6.54
Cost of cane / Tk. of output	0.57	0.58	0.58	0.51	0.75	0.60	5.64

Source: Annual reports of relevant sugar mills.

The cost of total inputs required per taka of output, remained as Tk.0.79 in 2007, Tk.0.83 in 2008, Tk.1.03 in 2009, Tk.1.38 in 2010 and Tk.1.13 in 2011. It indicates cost of input per taka of output increased from Tk.0.79 in 2007 to Tk.1.38 in 2010 due to increased value of output as compared to earlier years. Cost of inputs increased by 7.04 percent during the study period.

Cost of total input to per taka of output indicated that the highest loss was in 2010.

Table 3 shows various productivity ratios in PBSM during the period from 2007 to 2011. Overall cost productivity had Tk. 3.56 in 2007, 3.74 in 2008, 1.94 in 2009, 1.80 in 2010 and 1.64 in 2011 with an average of Tk. 2.54 for the study period. Overall cost productivity also

decreased by 15.45 percent during the study period. Overall productivity ratio reaches highest level in 2008 due to three times higher production as compare to the production of 2010. In 2008 fixed costs are spread on higher production and productivity increased favorably. Wages and salaries productivity shows fluctuating trend and it was declining by 22.79% during the study period. Output per taka of wages and salaries increased to the highest of Tk. 15.79 in 2008 and lowest of it was Tk. 4.25 in 2010. Capital employed productivity increased to Tk.3.01 in 2008 from Tk.1.96 in 2007 i.e. starting period. It was again extremely decreased to Tk. 0.86 in 2010 and then it was slightly increased to Tk. 1.40 in 2011. Capital employed productivity decreased during the study period by 6.67%.

Table 5. Panchgar Sugar Mills Ltd.

	2007	2008	2009	2010	2011	Avg.	EGR
Materials productivity	1.86	1.72	1.45	1.31	1.18	1.50	-9.17
Wages & salaries productivity	3.63	3.21	1.72	1.32	1.97	2.37	-12.20
Energy cost productivity	27.60	23.68	13.77	12.03	22.72	19.96	-3.89
Overheads cost productivity	13.73	8.85	5.09	5.27	7.74	8.14	-11.46
Overall cost productivity	1.08	0.95	0.65	0.56	0.65	0.78	-10.13
Machine productivity	1.22	1.05	1.02	0.99	1.12	1.08	-1.73
Fixed assets productivity	19.40	16.63	9.30	8.75	16.83	14.19	-2.84
Current assets productivity	0.92	1.17	0.88	0.43	0.98	0.88	1.22
Capital employed productivity	0.86	1.05	0.76	0.41	0.93	0.80	1.55
Cost of total input/Tk. of output	0.92	1.05	1.54	1.79	1.53	1.37	10.13
Cost of cane / Tk. of output	0.54	0.58	0.69	0.76	0.85	0.68	9.17

Source: Annual reports of relevant sugar mills.

Table 4 displays material cost productivity ranges from the lower of 1.33 in 2011 to the highest 1.95 in 2010 with the average of 1.70 and negative growth rate of 5.64. Cost of sugarcane per Tk. of output was highest and worst Tk.0.75 leaving only 0.25 paisa per Tk. of sales to meet up for other expenses. Wages and salaries productivity was highest Tk.3.37 in 2007 and lowest was Tk.1.71 in 2009. Negative growth rate of both energy cost productivity and overhead cost productivity were more or less the same for the study period. Overall cost productivity was highest in 2007 i.e., 1.02 and the lowest and better was in 2011 i.e., 0.74. Overall cost productivity was decreased by 6.54 percent. Cost of total inputs per one taka of output was lower in 2007 and saved only Tk.0.02 towards profit. In 2011, loss of Tk.0. 36 was per taka of sales. Fixed assets and current assets productivity were negative i.e. 2.94 and 9.30 percent respectively.

If we consider the material productivity as per Table 5, we will find that lower material productivity was Tk.1.18 in 2011 and highest of Tk.1.86 in 2007 with an average of Tk.1.50 and the growth rate was negative of 9.17 percent for the study period. Material cost per taka of output was very poor and ranges from 0.54 in 2007 to 0.85 in 2011. Wages and salaries productivity in PNSM showed fluctuating trend ranging from the lower of 1.32 in 2010 and with the average of Tk.2.37 and negative growth rate was 12.20 percent for the study period. Overall cost productivity was highest Tk.1.08 in 2007 and it was lowest to Tk.0.56 in 2010.

Overall cost productivity declined by 10.13 percent over the study period. Cost of total inputs per taka of output, shows increasing trend and it reached to Tk.1.79 in 2010 and it again declined to Tk. 1.53 in 2011. Cost of total inputs to per taka of output increased by 10.13 percent during the study period. These ratios revealed that the losses of the sugar mills in each year except in 2007 during the study period.

Table 6. Shyampur Sugar Mills Ltd.

	2007	2008	2009	2010	2011	Avg.	EGR
Materials productivity	1.71	1.72	1.61	1.44	1.22	1.54	-6.80
Wages & salaries productivity	2.61	2.49	0.92	0.69	1.10	1.56	-17.29
Energy cost productivity	20.69	17.64	10.37	10.99	17.03	15.35	-3.90
Overheads cost productivity	11.37	8.03	3.72	4.37	6.76	6.85	-10.41
Overall cost productivity	0.90	0.86	0.48	0.41	0.52	0.63	-11.25
Machine productivity	0.80	0.80	0.55	0.55	0.63	0.67	-4.84
Fixed assets productivity	3.14	3.18	1.28	1.29	2.42	2.26	-5.20
Current assets productivity	1.41	1.80	0.64	0.40	0.63	0.98	-15.98
Capital employed productivity	0.97	1.15	0.43	0.31	0.50	0.67	-13.22
Cost of total input/Tk. of output	1.11	1.16	2.07	2.46	1.94	1.75	11.25
Cost of cane / Tk. of output	0.59	0.58	0.62	0.69	0.82	0.66	6.80

Source: Annual reports of relevant sugar mills.

The overall cost productivity ratios during the study period seems to be 0.90 in 2007, 0.86 in 2008, 0.48 in 2009, 0.41 in 2010 and 0.52 in 2011. Average overall cost productivity was Tk.0.63 with a negative growth rate of 11.25 percent for the study period. An output per taka of sugarcane reached highest level of Tk.1.72 in 2008 as compared to lowest of Tk.1.22 in 2011. Productivity of factory overhead cost shows that maximum productivity was Tk.11.37 in 2007 and followed by Tk.8.03 in 2008, Tk.3.72 in 2009, Tk.4.37 in 2010, and Tk.6.76 in 2011. The average of this ratio was Tk.6.85 and declining trend was 10.11 percent during the period under study. Cost of total inputs per taka of output shows fluctuating trend during the period of study. Capital employed productivity was fluctuating and it was highest in 2008 and it decreased to Tk.0.31 in 2010 and it had decreased by 13.22 percent during the study period. Cost of total input to taka per output value showed very unfavorable. It was Tk.1.11 in 2007 and it was increased to Tk.2.46 in 2010 and it again decreased to Tk.1.94 in 2011.

Table 7. Statement showing physical machine productivity of selected sugar mills during the period from 2007 to 2011 Machine productivity of KSM in tons

	2007	2008	2009	2010	2011	Avg.	EGR
Sugar produced(tons)	12012	12130	5303	2246	3105	6959	-27.06
Actual Machine hours worked	3031	2968	1518	604	915	1807	-23.95
Machine productivity	3.96	4.09	3.49	3.72	3.39	3.73	-3.10
Machine hours per ton of sugar	0.25	0.24	0.29	0.27	0.29	0.27	3.10
Recovery rate	7.17	7.6	6.65	7.00	6.4	6.96	-2.27

Inter-factory comparisons of machine productivity cannot be done due to varying crushing capacity of the factories and in variation in quality of sugarcane crushed by the

factories. KSM showed machine productivity ratios ranging from the lowest of 3.39 tons in 2011 to the highest of 4.09 tons in 2008 during the period of five seasons. On an average KSM produced 3.73 tons of sugar in one machine hour. Machine productivity of this factory was decreased by 3.10 percent during the study period. KSM takes on an average 0.27 hours i.e. 18.2 minutes to produce one ton of sugar.

Machine productivity of NBSM in tons

	2007	2008	2009	2010	2011	Avg.	EGR
Sugar produced(tons)	21624	19964	12323	7448	15824	15437	-6.25
Actual Machine hours worked	4099	3655	2457	1613	3427	3050	-3.58
Machine productivity	5.28	5.46	5.02	4.62	4.62	5.00	-2.66
Machine hours per ton of sugar	0.19	0.18	0.20	0.22	0.22	0.20	2.66
Recovery rate	7.37	7.7	7.19	7.11	6.4	7.15	-2.82

North Bengal Sugar mills shows decreasing trend in machine productivity, it ranges from the lowest of 4.62 tons in both 2010 and 2011 to the highest of 5.46 tons in 2008. Machine productivity had decreased by 2.66 percent during the period under study. On an average 0.20 hours i.e. 12 minutes required to produce one ton of sugar. Time taken to produce one ton of sugar was increasing by 2.66 percent and to the contrary recovery rate was decreasing by 2.82 percent during the study period.

Machine productivity of PBSM in tons

	2007	2008	2009	2010	2011	Avg.	EGR
Sugar produced(tons)	9362	12985	4298	3006	4168	6763.80	-16.18
Actual Machine hours worked	2082	2856	1145	727	1222	1606.40	-10.66
Machine productivity	4.50	4.55	3.75	4.14	3.41	4.07	-5.53
Machine hours per ton of sugar	0.22	0.22	0.27	0.24	0.29	0.25	5.53
Recovery rate	7.03	7.33	6.15	6.98	5.54	6.61	0.16

Pabna sugar mills ltd. (PBSM) shows the machine productivity was the highest in 2008 i.e. 4.55 tons and the lowest 3.41 tons in 2011 with an average of 4.07 tons per hour during the period under study. The machine productivity was decrease by 5.53 percent during the study period. Average machine hours input required to produce one ton of sugar was 0.25 hours i.e. 15 minutes. Maximum time taken to produce one ton of sugar was 0.29 hours i.e. 17.4 minutes by the sugar mill.

Machine productivity of FSM in tons

	2007	2008	2009	2010	2011	Avg.	EGR
Sugar produced(tons)	11142	9932	6584	7040	7599	8459.40	-7.65
Actual Machine hours worked	3393	3061	2007	1877	2465	2560.60	-6.39
Machine productivity	3.28	3.24	3.28	3.75	3.08	3.33	-1.26
Machine hours per ton of sugar	0.30	0.31	0.30	0.27	0.32	0.30	1.26
Recovery rate	7.3	6.96	7.28	8.06	6.9	7.30	-1.13

Faridpur sugar mills ltd. (FSM) reveals the machine productivity was highest in 2010 i.e. 3.75 tons and lowest 3.08 tons in 2011 with an average of 3.33 tons per hour during the period under study. The machine productivity was decreased by 1.26 percent during the

study period. Average machine hours input required to produce one ton of sugar was 0.30 hours i.e. 18 minutes. Maximum time taken to produce one ton of sugar was 0.32 hours i.e. 19.2 minutes in 2011 by the sugar mill. Time taken to produce one ton of sugar was directly related with recovery rate of sugar.

Machine productivity of PNSM in tons

	2007	2008	2009	2010	2011	Avg.	EGR
Sugar produced(tons)	12267	8158	4159	4000	5794	6876	-15.00
Actual Machine hours worked	3192	2902	1719	1594	2421	2366	-5.53
Machine productivity	3.84	2.81	2.42	2.51	2.39	2.80	-9.47
Machine hours per ton of sugar	0.26	0.36	0.41	0.40	0.42	0.37	9.47
Recovery rate	7.44	6.87	6.00	6.18	5.97	6.49	-4.40

Panchgar Sugar mills Ltd. depicts that machine productivity was decreased by 9.47 percent; it ranges from the lowest of 2.39 tons in 2011 to the highest of 3.84 tons in 2007. On an average 0.37 hours i.e. 22.2 minutes required to produce one tone of sugar. Machine hours taken by the sugar mills showed more fluctuating from 0.26 hours in 2007 to 0.42 hours in 2011 and the growth rate was unfavorable by increasing 9.47 percent during the study period. Sugar recovery rate was decreased by 4.40 percent for the study period.

Machine productivity of SHSM in tons

	2007	2008	2009	2010	2011	Avg.	EGR
Sugar produced(tons)	6735	6416	2103	2083	3406	4148	-13.64
Actual Machine hours worked	2319	2201	816	744	1304	1477	-11.51
Machine productivity	2.90	2.91	2.57	2.80	2.61	2.76	-2.12
Machine hours per ton of sugar	0.34	0.34	0.39	0.36	0.38	0.36	2.12
Recovery rate	7.04	7.24	6.45	6.75	6.46	6.79	-1.72

Shyampur sugar mills shows fluctuating trend of in machine productivity, it ranges from the lower of 2.57 tons in 2009 to the highest of 2.91 tons in 2008 with an average of 2.76 tons. Minimum machine hours required per ton of sugar production was 0.34 hours i.e. 20.4 minutes in both 2007 and 2008 seasons and maximum of 0.39 hours i.e.23.4 minutes in 2009 season. Growth rate of machine productivity was decreased by 2.12 percent for the study period.

Model Formulation

Model formulation is mainly about building the proposed multiple linear regression model in which the dependent and independent variables are identified. In this model, the dependent variable is yearly sugar production. There are 7 independent variables were considered in the model. These are recovery rate of sugar, seasonal crushing days, total cane purchased, actual machine hours; mills gate purchase of sugarcane, road head purchase of sugarcane, capacity utilization.

Hypotheses testing

1. Let we assume the null hypothesis that there is no significant variation in productivity among the large-sized selected sugar mills during the study period.

ANOVA: Single factor

Source of variation	SS	Df	MS	F	P-value	F crit
Between Group	69013923	9	7668214	4.41	0.0	2.39
Within Group	34755836	20	1737792			
Total	1.04E+08	29				

The calculated value for F (9, 20) at 5% level of significance is 2.39. The table value of F (4.41) is greater than the table value. Hence we reject the null hypothesis and conclude that there is significant variation in productivity among the three large sized sugar mills.

2. Let we assume the null hypothesis that there is no significant variation in productivity among the small-sized selected sugar mills during the study period.

ANOVA: Single factor

Source of variation	SS	Df	MS	F	P-value	F crit
Between Group	32441027	9	3604559	21.16	0.0	2.39
Within Group	3405615	20	170280			
Total	35846642	29				

ANOVA indicated the calculated value F is 21.16 and table value is 2.39 with 9, 20 degrees of freedom at 5% level. The calculated value of is 21.16 which is higher than the table value. So the hypothesis is rejected and we can conclude that there is significant variation in productivity among the small-sized sugar factory during the study period.

3. Let we take the null hypothesis that there is no significant correlation of physical sugar production with recovery rate and machine productivity.

	KSM	NBSM	PBSM	PNSM	FSM	SHSM
Production & recovery rate	0.77	0.34	64	0.95**	-0.46	0.84*
Production & M.productivity	0.84*	0.76	0.77	0.95**	-0.28	0.77

*Correlation is significant at the 0.05(1-tailed).

** Correlation is significant at the 0.01 level (1-tailed).

The physical production of sugar is significantly correlated with recovery rate in PNSM (0.95**) at 1 percent level and in SHSM (0.84*) at 5 percent level and other selected sugar mills showed insignificant correlation. On the other hand KSM showed significant correlation of sugar production with machine productivity (0.84*) at 5 percent level and PNSM had significant correlation (95**) at 1 percent level during the study period. It is to be noted that FSM shows fully reverse and negative correlation. It has correlation of physical production of sugar to recovery rate (-0.46) and with machine productivity (-0.28) for the study period.

Summary of Findings

The study used data from 2007 to 2011 to analyze the value of production and physical productivity measurement in the sugar industry in Bangladesh.

Average materials cost productivity decreased in all the selected sugar mills of which the highest and worst decrease was 13.15 percent in PBSM followed by PNSM(9.17), NBSM(6.99) SHSM(6.80), FSM(5.64) and KSM(4.61%).

Average energy cost productivity was highest in PBSM i.e. 82.18 followed by NBSM (41.33), FSM (27.06), PNSM (19.66), SHSM (15.35) and KSM (14.21) during the study period.

The highest average overall cost productivity was 2.54 for PBSM followed by NBSM (1.01), FSM (0.87), PNSM (0.78), KSM (0.73) and the lowest was by SHSM (0.63) during the study period.

The lowest average cost of input required per taka of output were Tk.0.45 in PBSM followed by Tk.1.03 in NBSM, Tk.1.17 in FSM, Tk.1.37 in PNSM, Tk.1.56 in KSM and Tk.1.75 in SHSM.

Average cost of materials to output value was the most worthless for PNSM i.e., Tk.0.68 followed by TK.0.66 in SHSM, Tk.0.61 in both KSM and NBSM. Tk.0.60 for FSM and the lowest and better was Tk.0.20 for PNSM for the study period. Average total cost of input to output value was Tk.1.75 for SHSM followed by KSM (Tk.01.56), PNSM (Tk.1.37), FSM (Tk.1.17), NBSM (Tk.1.03) and the best was for PNSM (Tk.0.45) for the study period. Only the output value of PBSM can meet up its all cost by selling the sugar.

Machine productivity in times it is found that the minimum time was taken by NBSM i.e., 20 minutes and highest time for producing one tons of sugar was taken by PNSM i.e., 0.37 minutes during the study period.

Overall cost productivity had significant correlation with capital employed productivity in some sugar mills and positive but insignificant correlation with some sugar mills. The coefficient of correlations are 0.97 in SHSM, 0.92 in both KSM and NBSM, 0.83 in PBSM, 0.62 in PNSM and 0.53 in FSM for the study period. ANOVA indicated that there was significant difference in productivity measurement among the large sized sugar mills and small sized sugar mills during the study period.

Recommendations

It is recommended that an appropriate policy for sugar industry may increase productivity of sugar. Such policy should be designed to avoid losses in different stages of sugar factory. A restrictive policy measure on sugar imports should be adopted in the country like periodic review of tariff rates on sugar imports.

Cost reduction schemes and controlling cost of stores, chemical, labor and overhead is highly essential for the sugar factory in Bangladesh.

Motivating the farmers to increase area under sugarcane cultivation and to improve quality of sugarcane is highly essential for survival of sugar industry.

Introducing incentive and bonus scheme for the harvesting and transportation workers for seeking their co-operation is very important for in increasing labor productivity.

Modernization of plant and machinery through appropriate automation is required and setting up of by-product industries along with co-generation of electricity.

Conclusion

Sugar as an important raw material for many industries, has the potential to influence the country's gross domestic product. The domestic sugar production in Bangladesh has been affected by different factors. This study has identified some of the factors needed to tackle to increase the productivity of sugar factory in our country. Supply of sufficient quality of sugarcane and multiple use of byproduct will increase the productivity position of sugar mills in Bangladesh.

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