Productivity Analysis of Black Tea Production in Tea Industry

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Abstract
India is the largest producer as well as largest consumer of black tea in the world. At present, the productivity growth in India is lagging behind the other countries like Kenya, Sri Lanka, and China etc. The main objective of the present study is productivity analysis of different tea estates of upper Assam district in India and to compare the results. A quantitative relation between total productivity and partial productivity has been developed from the data collected from 10 nos. of tea estates situated in different locations of upper Assam district. In the present work similar tea estates are taken into consideration for comparison. This data were regressed using regression software Minitab-14 to develop the correlation model between total productivity and partial productivity. The developed correlation would definitely contribute to change the management's policy for their business to increase productivity. The general factors affecting cost of tea production have been investigated by using Ishikawa's Cause and Effect diagram. Some corrective measures to control such factors have been identified in this study.

Keywords
Tea Industry,Total Productivity, Partial Productivity, Regression Analysis

I. Introduction and Overview

To study about production system of a tea industry and cost associated with it, it is necessary to know about its historical background and present status. Tea industry plays an important role in the state economy as well as in the national economy. Tea production started with tea cultivation. In India, tea cultivation started in the state of Assam, the north east part of the country during British period. Due to favorable climatic condition tea industry started in the state in 18th century. Suparna [3] analyzed the pattern of discovery of tea in Assam, the first tea growing state of India. The first discovery of the tea plant growing wild in India (upper Assam) was made in the year 1821. In 1835 the first tea garden was opened at Lakhimpur district in Assam. ManiramDewan (1806-1858)was the first Indian tea planter to start his tea estate in Sivsagar district.

In the North East India, the state Assam produces around 53% of the country's total production. It also employs more than 10% of the state's workforce or around 12 lacks of people. Tea is mostly grown in Brahmaputra and Barak valley area of Assam.Nizara [2] studied the development profile of tea industry in Assam in term of production and growth rate of area. The state wise status of tea plantation area and production in the year 2013-14 is presented in the Table 1.

Table 1: Tea Area as on 31-12-2013 & Production in 2013-14

State/District	Area [In Th. hectares]	Production [In M. Kg]
Assam valley	270.92	581.03
Cachar	33.48	48.02
Total Assam	**304.40**	**629.05**
Darjeeling	17.82	8.91
Dooars	72.92	177.85
Terai	49.70	125.34
Total West Bengal	**140.44**	**312.10**
Others Arunachal Pradesh, Tripura, Manipur, Mizoram, Nagaland, Sikkim, Uttrakhand, Himachal Pradesh, Bihar ,Orissa	12.29	23.92
Total North India	**457.13**	**965.07**
Tamil Nadu	69.62	174.71
Kerala	35.01	63.48
Karnataka	2.22	5.52
Total South India	**106.85**	**243.71**
All India	**563.98**	**1208.78**

Source: Tea Board, India

II. Objective of the Present Study

- To identify the different factors affecting cost of black tea production in the tea industry.
- Productivity analysis of different tea estates of upper Assam district and to compare the results.
- To establish a relationship between total productivity and partial productivity.

III. Productivity Measurement Model

Different authors have been suggested different model for the measurement of productivity at different level like business level, national accounts or industry level, etc.

However all of them should satisfy the basic productivity equation which is defined as

Productivity = Output ÷ Input.

The following are some well-known models for analysis of productivity

A. Kendrick-Creamer model

Kendrick and Creamer (1955) introduced productivity indices at the company level which was published in their book "Measuring company productivity". Their indices are basically two types; total productivity and partial productivity.

This method is suitable for calculating productivity index at company level. But this method is not suitable for calculating total productivity index in industry since it does not take into account all the input pertaining to industry such as business services, energy etc.

B. Craig-Harris Model

Craig and Harris (1972-75)using the index approach at the company level, they define total productivity measure.

This method is suitable for computation of productivity at firm level, service sector and yields physical productivity. But it is not suitable for tea industry because it does not take into account all inputs relevant to tea industry.

C. American Productivity Centre Model

American Productivity Centre has measured that productivity relates profitability and price factor.

It is suitable for accounting productivity at business level and easy to compute productivity with managerial data like profitability and price recovery factor.But it is not suitable for tea industry because it does not considered physical quantity of goods produced which may not be properly represented by profitability.

D. Productivity Accounting Model

H. S. Davis introduced this model. This model takes into account all possible outputs and inputs used, keeping aside external factors such as price rise etc.

This model is one of the best models. It fulfills almost all the requirements of accounting for productivity.

Since it takes care of all types of inputs, requires monetary equivalent of inputs and outputs and keep out external factors such as price rise etc.

E. Productivity Model for a Tea Industry

This model has been published by R. Gupta and S.K. Dey [1]. This model is shown below

$$\text{Total Productivity} = \frac{Q_t}{(L+C+R+E+S+Q)}$$

In this modified model all values relating to outputs and inputs are in monetary equivalent deflated to a base year using a suitable price index or an average inflation rate so as to take care of quality.

IV. Methodology and Tools/Techniques Used

The study has been carried out with the following steps:

1. Data collection in designed format from different tea estates (in the upper Assam district) regarding their labor input, capital input, materials input, energy input, welfare input, miscellaneous input, total tea made, selling price, and total running hours etc.
2. Personal interview and observations made during field visits and also secondary data collected from literature survey at the Research Centre.
3. Identification of the factors affecting cost of black tea production using Ishikawa's Cause and Effect diagram.
4. Productivity analysis of black tea production in different tea estates carried out and the results are compared.
5. Applying regression analysis, regression equation relating total productivity and partial productivity using MINITAB-14 is established.

V. Field Visit

Ten tea estates in upper Assam district were visited for the study. The last three years data are collected in designed format from those tea estates of upper Assam district regarding their labor input, capital input, materials input, energy input, welfare input, misc. input, total tea made, selling price etc. These data are analyzed using Regression software to develop the correlation model between total productivity and partial productivity. This partial productivity includes labor, capital, material, energy, welfare and miscellaneous productivities.Productivity analyses of black tea production in different tea estates are compared.

VI. Manufacturing Process of Black Tea

Once the tea leaves are plucked from the gardens and transported to the factory, it goes through various stages in factory. All the processes involved in the tea processing play an important role in building the quality of tea. Careful and proper processing normally bring out the full potential of the green leaf.

The basic operations involved in black tea manufacturing are:

1. Withering
2. Rolling (plus crushing, tearing and curling in case of C.T.C.)
3. Fermenting
4. Firing
5. Sorting and Grading
6. Storage and Packing

The manufacturing processes have many inputs and output factors, which affects productivity.

Such input factors are-

1. **Human input:** Administrative staff, professional, field and factory workers etc.
2. **Capital input: (**i) Fixed: Land, building, machinery, tools and equipment, others. (ii) Working: Cash, inventory, account, transportation etc.
3. **Material input:** Raw material (own and purchased), purchased parts and others.
4. **Power or Energy input:** Electricity, fuels, oils etc.
5. **Welfare and subsidized ration input:** Health, education, entertainment, safety, subsidized ration for labor and staff,etc.
6. **Miscellaneous:** Administrative expenses, repair and maintenance, insurance, others.

Such output factors are:

- Quality finished product for sale, other incomes.

VII. Factors affecting cost of black tea production

The different possible causes of rising cost of production of tea have been presented with the Cause and Effect diagram as shown in the fig. 1. The diagram is used to explore all the real causes or inputs that results in a single effects or output.

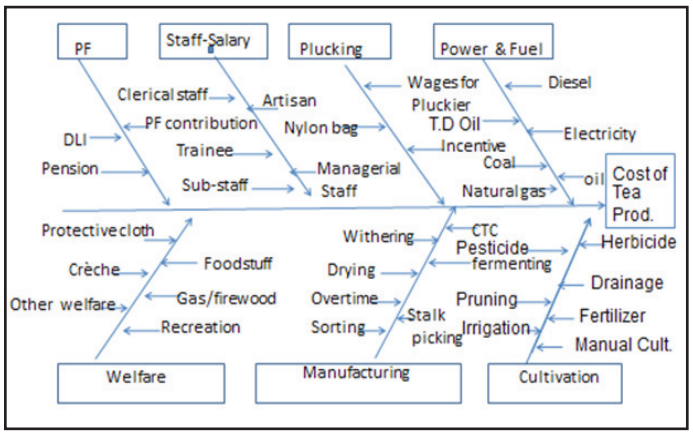

Fig. 1: Ishikawa Diagram Showing the Factors Affecting Cost of Tea Production

From the diagram it is seen that the following are the main input factors that affect the cost of tea production.

1. **Human input:** Managers, staff, workers, trainee, clerical staff, medical, artisan, etc.
2. **Capital input:** (i) Manufacturing [fixed and working] (ii) Cultivation [herbicide, pesticide, drainage, irrigation, pruning etc.]
3. **Material input:** Raw material (green leaf), manure (organic and chemical), nylon bag, water, etc.
4. **Energy and fuel input:** Electricity, fuels (petrol, diesel, gas, coal, oil, T.D oil) etc.
5. **Welfare input:** Medical, school, recreation, ration, maternity benefit, crèche, cooking fuel, canteen, protective clothing, provident fund and pension etc.

VIII. Productivity Measures

A. Total Productivity Measure (TPM)

Total Productivity is the ratio of total output to the sum of all input factors.

$$\text{Total Productivity} = \frac{\text{Total Tangible Output}}{\text{Total Tangible Input}}$$

Where,

Total tangible output = Value of finished goods produced + value of partial units produced + dividends from securities + interest from bonds + other incomes.

Total tangible input = Value of (human + capital + material + energy + welfare + other expenses)

B. Partial Productivity Measures (PPM)

Partial productivity is the ratio of output to one class of input. For example, labor productivity, capital productivity etc.

$$\text{Partial Productivity} = \frac{\text{Total Output}}{\text{Individual Input}}$$

Table 2: Output, input and total productivity from 2011 to 2014 (Tea Estate 1)

Year	Output per year		Input(In Lacks) per year					
	Tea made(Kg)	Selling Price(Rs)	Labor	Capital	Material	Energy	Welfare	Misc.
2011-12	1600250	112.25	309.79	130.25	190.47	223.14	168.5	169.35
2012-13	1583354	130.14	306.00	143.75	198.42	235.63	185.5	178.63
2013-14	1448391	134.25	338.76	155.18	205.34	245.67	196.3	187.50

Table 3: Total Productivity from 2011 to 2014 (Tea Estate1)

Year	2011-12	2012-13	2013-14
Total Input (In Lacks)	1191.50	1247.93	1328.75
Total Output(In Lacks)	1796.28	2060.58	1944.46
Total Productivity = $\frac{Output}{\text{Input}}$	1.51	1.65	1.46

Table 4: Output, Input and Total Productivity From 2011 to 2014 (Tea Estate 2)

Year	Output per year		Input(In Lacks) per year					
	Tea made (Kg)	Selling Price (Rs)	Labor	Capital	Material	Energy	Welfare	Misc.
2011-12	193945	85.25	29.58	15.25	20.46	27.37	20.50	21.64
2012-13	207025	100.15	31.46	17.46	22.25	31.37	23.63	22.82
2013-14	239550	110.40	35.69	20.40	25.26	32.64	24.50	25.74

Table 5: Total Productivity From 2011 to 2014 (Tea Estate2)

Year	2011-12	2012-13	2013-14
Total Input(In Lacks)	134.08	148.99	164.23
Total Output(In Lacks)	165.33	207.34	264.46
Total Productivity = $\frac{Output}{\text{Input}}$	1.23	1.39	1.61

Table 6: Output, Input and Total Productivity From 2011 to 2014 (Tea Estate 3)

Year	Output per year		Input(In Lacks) per year					
	Tea made (Kg)	Selling Price (Rs)	Labor	Capital	Material	Energy	Welfare	Misc.
2011-12	837274	130.00	130.04	122.85	124.97	120.54	118.44	121.75
2012-13	830737	133.00	146.34	130.45	132.32	128.75	120.50	125.84
2013-14	764283	140.00	157.82	140.24	138.78	134.93	124.56	130.65

Table 7: Total Productivity From 2011 to 2014 (Tea Estate3)

Year	2011-12	2012-13	2013-14
Total Input(In Lacks)	738.59	784.20	826.98
Total Output(In Lacks)	1088.46	1104.88	1070.00
Total Productivity= $\frac{Output}{Input}$	1.47	1.41	1.29

Graphical representation of total productivities of the Tea Estates 1, 2 and 3, for the last three years are shown in the fig. 2.

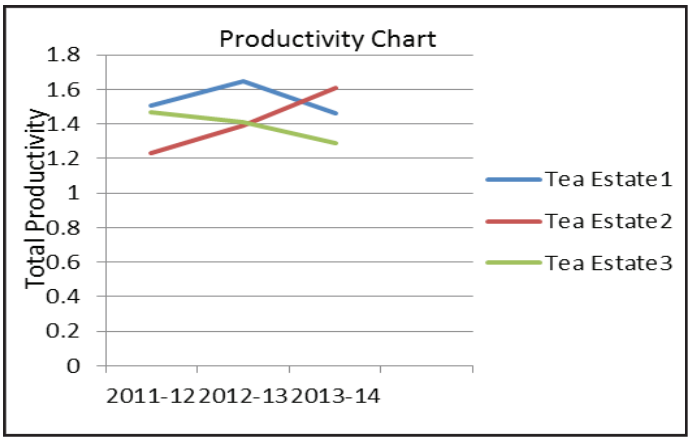

Fig. 2: Total Productivity Comparison Chart [Tea Estates 1, 2 and 3]

IX. Results and Discussion

A. Total Productivity

Total productivity measure is easy to calculate and more accurate representation of the total picture of the tea estates because it is easily related to total cost, considering all quantifiable inputs and outputs.

The results of total productivity in the tea estate 1, as shown in the Table 3, it is seen that the total productivity is more in the year 2012-2013.

Again evaluating data from tea estates 2, as shown in the Table 5, it is seen that total productivity increases gradually from 2011 to 2014.

The total productivity increasesdue to increase ininputs resulting in a very large increase in output.

Evaluating data from tea estates 1, as shown in the Table 3, it is seen that total productivity increases in the year 2012-13 but it decreases in the year 2013-14.

In the tea estates 3, as shown in the Table 7, it is also seen that total productivity decreases from 2011 to 2014.

The total productivity decreases as the inputs are increased but the output is not increasing proportionately.

B. Partial Productivity

The partial productivity measure is a tool to pinpoint improvement considering only one input factor at a time. For each input factor partial productivity is computed to get different productivity indexes like labor productivity index, capital productivity index, etc.

Among the partial productivity measures, labor productivity index is the most common and popular at the national level.

X. Establish the Relation Between Total Productivity and Partial Productivity

Regression software (MINITAB-14) is used to develop the correlation model between total productivity and partial productivity.

Total productivity and partial productivity are related through the regression equation as given below.

Total Productivity = - 0.0172 + 0.0430 L + 0.0144 C + 0.0369 M + 0.0243 E + 0.0355 W + 0.0153 MI

Where,

L-Labor, C-Capital, M-Material, E-Energy, W-Welfare, MI-Miscellaneous.

Total productivity is dependent variable and partial productivity is independent variable. This equation has been developed on the background of C.T.C method of tea processing.

From the above equation it is seen that the coefficient of labor (L) and material (M) are more. So the labor and material are the key factors for the productivity change and capital has the least effect. Since labor and material productivity has the major influence on total productivity, hence to increase total productivity there must be increase in labor and material productivity by reducing labor and material cost to the possible extent.

XI. Measures to Reduce Labor and Material Cost

From literature study and evaluating data from different tea estates, it may be suggested to reduce the labor and material cost during production in the following ways:

- By using semi-automatic equipment, tea industry can move towards automation to minimize the labor cost and efficient use of resources without compromising the quality.
- Proper factory layout design, which leads to enhanced productivity.
- Energy cost of movement within the factory premises can be minimized by proper arrangement of machinery and processing steps.
- Labor productivity may be improved by improved work method. Proper method study and job design can improve the results to a great extent.
- Using rope conveyor system connecting different stages of processing unit can reduce material handling expenditure to a considerable amount.
- Following proper maintenance schedule of the processing machinery improves the efficiency of machineries and workers, at the same time saves energy as well.
- The material input for the tea estate mainly comprised of packaging material, chemical fertilizer and purchased green leaf.

The tea estate management is suggested to go for organic manure which would cost much less than the chemical fertilizer currently in use. It can be produced in the estate itself in the form of compost manure formed with the biodegradation of the weeds, which in turn would save the expenditure incurred in the form of Weedycide.

The tea estate management is also suggested to search for an

alternative of current material at lower cost.

- Further, the management may go for new plantation in the vacant land of the estate to curtail the expenditureincurred in the purchase of extra green leaf from the outside agency.

Marginal areas that are potentially low yielding should be utilized for alternative planting like 'Jatropha' or 'Mesuaferra' planting, which has global demand for producing bio-diesel.

XII. Conclusion

The study identifies the various factors affecting cost of black tea production. From productivity analysis and regression equation it is seen that labor and material productivity has the major influence on total productivity. Thisequation has been developed on the background of C.T.C. method of tea processing of the tea estates under study. It isobserved from results and discussion that energy and welfare also take major role among the factors of tea production.

The cost of labor and material can be reduced or controlled to some extent by adopting the measures discussed above. The welfare cost can be considered as social cost. The cost of manure can be reduced to a great extent by farming organic tea on plantation scale which eliminates the cost of chemical fertilizers and pesticides without affecting yield and quality of tea.

The findings of the study will help the tea status in improving productivity and also will motivate further study in this field.

XIII. Acknowledgement

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