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DEVELOPMENT OF A PRODUCTIVITY MEASUREMENT MODEL FOR TEA INDUSTRY

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ABSTRACT

India is the largest tea producing country in the world and tea contributes 1% of the GDP of the country, apart from providing a direct livelihood to a large number of workers. However, in the recent past the productivity performance of Indian tea industry has not been very satisfactory. India's predominance in the tea production is on decline and this has already started showing its bad effect on all the stakeholders. The tea industry in India must search for a comprehensive productivity improvement strategy to overcome the challenge of high competition from other emerging tea producing countries like Srilanka, Kenya, China, Bangladesh and Indonesia in the global level. As a pre-requisite, the quest for a productivity improvement programme follows productivity measurement. But, meticulous literature survey reveals that no study has been undertaken so far on the productivity measurement of a tea industry. Also, the productivity measurement methods presented in the literature are usually too intricate and difficult to apply. The competency and expertise needed for their implementation is scarce in context of Indian tea industry. With this backdrop this paper attempts to propose a relatively simple productivity measurement model suited to tea industry. For this, productivity accounting model is used and suitably given the form so as to fit to a tea industry. A case study, conducted in a tea industry in Assam, India, to analyse the performance of the model is presented. The study reveals that the model is comprehensive and satisfies the six criteria of measurement theory such as validity, comparability, completeness, timeliness, inclusiveness and cost-effectiveness. Further, the study reveals that the proposed model identifies the areas of poor resource utilization responsible for measured total productivity decline in the tea industry. These resources are labour, material and energy and a number of suggestions have been put forward as a mitigating measure.

Keywords: tea industry, productivity measurement model, total factor productivity.

1. INTRODUCTION

In all aspects of tea production, consumption and export, India has emerged to be the world leader, mainly because it accounts for 31% of global production. It occupies an important place and plays a very useful role in the national economy. It is perhaps the only industry where India has retained its leadership for over the last 150 years.

Tea Industry provides direct employment to more than a million workers mainly drawn from the backward and economically weaker section of the society. It is also a substantial foreign exchange earner and provides sizeable amount of revenue to the State and Central Exchequer. Presently, Indian tea industry is having [1].

- 1655 registered tea manufacturers,
- 2008 registered tea exporters,
- 5148 number of registered tea buyers,
- Nine tea auction centres.

But unfortunately, in the recent past the productivity performance of Indian tea industry has not been very satisfactory. India's predominance in the tea world is on the decline with many of the old fields are in need of replanting, processing facilities requiring modernization and welfare structures calling for up gradation. At the global level the Indian tea industry is finding it increasingly difficult to make ends meet, caught between rising costs on one hand and stagnant or declining prices on the other. Low productivity and the increase in the cost of production have become severe challenges faced by the Indian tea industry. Low productivity performance has resulted in the low or below unity profitability in most of the tea manufacturing industries, which discouraged the owners to invest for productivity improvement, thereby causing further declination in the productivity status. The pre-requisite for the improvement of productivity of a particular tea manufacturing unit or the sector as a whole is to measure its productivity status. But the tea industry who are in urgent need of a comprehensive and immediate productivity improvement programme for their survival in the long term, seem to be not interested in the assessment of their productivity status. The reasons for this apparent indifference appears to be lack of knowledge, complex input-output relation for tea industry, fear of changes, lack of competency, lack of management commitment and shortfall of personnel competency on appreciation and understanding of productivity. In the tea industry, which is overwhelmingly in the private sector, the primary profit orientation is interlinked with the objective of productivity improvements. However, no empirical research has been carried out to estimate the productivity status and its temporal growth in the tea factories in India. In the literature also no work has been reported on the productivity measurement exclusively for this traditional, labour and energy intensive industry, which possess an important place in national economy for a developing country like India. Therefore, there is a great need to research the productivity measurement of the tea processing units of the country and a study felt necessary on the productivity measurement of a tea manufacturing

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unit to mark the beginning of the much felt quest for productivity improvement in tea sector. Keeping this ground level scenario in mind, this paper presents a case study, conducted at the Rosekandy tea estate, Silchar, Assam, India, to measure its productivity performance. The tea estate produces Cut-tear-curl (CTC) category of black tea. The main purpose of this study is to identify the output and inputs peculiar to tea industry and to develop a productivity measurement model specific to the tea industry based on productivity accounting model to assess the productivity status using those inputs and output.

The objectives of the study are:

- To develop productivity measurement model specific to tea industry for the computation of Total factor productivity (TFP), Partial productivities and to monitor their growth.
- To evaluate the model thoroughly using six criteria from measurement theory to establish its appropriateness.
- To analyse the results of the case study in hand to identify the areas of poor resource utilization and to suggest improvement techniques.

2. REVIEW OF LITERATURE

The term ‘productivity’ means different things to different persons. As a phenomenon, it ranges from efficiency to effectiveness, to rates of turnover and absenteeism, to output measures, to measure of client or consumer satisfaction, to intangibles such as disruption in workflow and to further intangibles such as morale, loyalty and job satisfaction. To put it bluntly, the definition of productivity is complex and this is because it is both a technical and managerial concept. Productivity is a matter of concern to government bodies, trade unions and other social institutions not minding the disagreements over its conceptualization by different groups and individuals. Hence, discussing productivity at all levels is common because of the direct relationship between productivity and the standard of living of a people. It is perceived that the more different are the goals of the different individuals, institutions and bodies that have a stake in productivity as a problem, the more different their definitions of productivity will be [2]. Krugman [3] intended to assert that defining or measuring productivity is a Herculean task when he asserted that “productivity isn’t everything, but in the long run it is almost everything”. The least controversial definition of productivity is that it is a quantitative relationship between output and input [4, 5]. In the OECD (Organisation for economic co-operation and development) manual productivity is commonly defined as a ratio of a volume measure of output to a volume measure of input use [6]. While there is no disagreement on this general notion, a look at the productivity literature and its various applications reveals very quickly that there is neither a unique purpose for, nor a single measure of, productivity. The objectives of productivity measurement include: Technology, efficiency, real cost saving procedure, bench marking process, standard of living. Tangen [7] summarized a number of variations in the definition of productivity found in different literatures. Eatwell and Newman [8] defined productivity as a ratio of some measure of output to some index of input use which means that productivity is nothing more than the arithmetic ratio between the amount produced and the amount of any resources used in the course of production. This conception of productivity goes to imply that it can indeed be perceived as the output per unit input or the efficiency with which resources are utilized [9].

The basic content seems to be the same in many definitions of productivity. However, within the similar definitions, there are three broad categorizations: i) the technological concept: the relationship between ratios of output to the inputs used in its production; ii) the engineering concept: the relationship between the actual and the potential output of a process; and iii) the economist concept: the efficiency of resource allocation [10]. According to Sink [11], the overall performance of a company is comprised of at least seven criteria: effectiveness, efficiency, quality, productivity, quality of work life, innovations, and profitability. Productivity is thus a key success factor for all companies. Hannula [12] has stated that organizations must be able to continuously increase their productivity in order to stay profitable. Therefore, productivity should also be managed. Productivity measurement is one traditional and practical tool for managing productivity. Ideally, total productivity would be measured. Total productivity is the total output divided by the sum of all inputs. As a concept, total productivity is fairly simple. However, the measurement of total productivity is very difficult in practice. The main problem is that different outputs (products and services) and inputs (e.g. labour, material, energy) cannot be summed up. An obvious solution would be to use monetary values but then it would be about profitability measurement. There are several more practical methods available for productivity measurement. Perhaps the most common of them is to use partial productivity measures. Partial productivity ratios can be calculated by dividing total output by some input factor. For example, labour productivity is the ratio between total output and labour input. If partial productivity ratios cannot be calculated because the total output cannot be determined, even more simple method is to use physical productivity measures. They are obtained by dividing some typical output (e.g. number of serviced customers or production amount of main product) by an essential input (e.g. machine hours or labour hours). Productivity combines the concepts of effectiveness and efficiency, where effectiveness is the degree to which end results are achieved to the required standard [13]. Growth is a function of total factor productivity (TFP), which is the aggregation of partial productivities [14]. Many papers evaluate critically the roles of investment and physical capital accumulation in economic growth and development. The differences in physical capital accumulated between countries seem not sufficient to explain the development gap in the world repartition of wealth. Growth and development accounting provide a powerful and simple tool to study these

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enormous cross-country differences in income per worker level and growth. Growth accounting provides a breakdown of observed economic growth into components associated with changes in factor inputs and a residual that reflects technological progress and other elements. The basics of growth accounting were presented in [15, 16, and 17]. According to Kaydos [18] productivity and subsequently performance measurement has been regarded as a prerequisite for continuous improvement. When focusing on the industries, national, and international levels, many approaches have been designed by economists such as the total factor productivity (TFP), or Bureau of Labor Statistics (BLS) multifactor productivity techniques [19, 20]. Craig and Harris [21] provided a total productivity model at the firm level comprising output and four inputs. Mike Hannula [12] devised a method of expressing total factor productivity as a function of partial productivity. Houseman [22] noticed the effect of outsourcing and off shoring in the productivity statistics of the U.S. manufacturing industry. Diewart [23] discussed the problems whenever there is a need to measure productivity growth. Sumanth [24] considers the impact of all input factors on the output in a tangible sense. Total productivity [25], total productivity in firm [26] and total productivity of products [27] are defined as mentioned below,

Total productivity = (Total tangible output) ÷ (Total tangible input)
Total productivity in a firm = (Total output of the firm) ÷ (Total input of the firm)
Total productivity of product I = (Total output of product i) ÷ (Total input for product i)

Rogers [28] discussed various methods to analyse productivity and stated that productivity changes can be caused either movements in the best "best practice" production technology or a change in the level of efficiency. Berndt [29] surveyed and interpreted several of the most important aspects underlying relationships technical progress, productivity growth and energy use viewed from the vintage of an economist. He concluded that the common theme of embodiment, diffusion and learning are critical to understand the forces linking energy usage, technical progress and productivity growth.
S. Mahapatra [30] studied the energy consumption pattern by various section of a tea processing unit, situated in Assam and found that the consumption Figures were at the higher side of the standard laid by the National productivity council of India. He identified the systems and equipments of low efficiency and suggested methods to improve them. Saha *et al.* [31] studied the economic profitability of made tea cultivation in Bangladesh along with categorization of the tea producing regions of the country as per benefit-cost ratio. Bora S. *et al.* [32] adopted comparison/matching technique based on ANN for colour of test image with a standard dataset. Rudramoorthy *et al.* found that keeping quality of tea mainly depend on the drying technique and final moisture content of the made tea. There is direct relationship between product quality and energy consumed per kilogram of made tea exploring the scope for improvement of energy productivity.

3. MAIN TYPES OF PRODUCTIVITY MEASURE

Broadly speaking, productivity is the ratio of output to input in a specific production situation. There are many different productivity measures. The choice between them depends on the purpose of productivity measurement and, in many instances, on the availability of data. Broadly, productivity measures can be classified as single factor productivity measures or partial productivity measures (relating a measure of output to a single measure of input) and multifactor productivity (MFP) measures (relating a measure of output to a bundle of inputs). When multifactor productivity measures takes into account all the inputs of production it is termed as Total factor productivity (TFP) Another distinction, of particular relevance at the industry or firm level is between productivity measures that relate some measure of gross output to one or several inputs and those which use a value-added concept to capture movements of output. When the intermediate inputs or the endogenous inputs are deducted from the gross output it results in value added.

Table-1 depicts these criteria to enumerate the main productivity measures. The list is incomplete in so far as single or partial productivity measures can also be defined over intermediate inputs (energy, material and services) and labour-capital multifactor productivity can, in principle, be evaluated on the basis of gross output [6]. However, in the interest of simplicity, Table-1 is depicted with the most frequently used productivity measures. These are measures of partial productivities of labour and capital, and multifactor productivity measures (MFP), either in the form of capital-labour MFP, based on a value-added concept of output, or in the form of capital-labour-energy-materials MFP (KLEMS), based on a concept of gross output. Among those measures, value-added based labour productivity is the single most frequently computed productivity statistic, followed by capital-labour MFP and KLEMS MFP [7].

Conceptually, output embodies both quality and quantity and this creates sometimes confusion that the productivity measure is unfounded in the sense that they do not take quality into consideration. Such arguments may be true in case of very simple productivity ratios. In those ratios, the quality of the output or input is often ignored. But, when the output is measured in deflated net sales, for example, the quality of the products or services is included in the function. However, quantifying quality changes in productivity measurement is always a measurement problem, not a conceptual problem. At the conceptual level quality of the output and the input are very much included in the productivity ratio.

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Table-1. Overview of main productivity measures.

Type of output measure ↓	**Type of input measure**			
	Labour	Capital	Capital and labour	Capital labour and intermediate inputs (energy, material and services)
Gross output	Labour productivity (Based on gross output)	Capital productivity (Based on gross output)	Capital-labour MFP (based on gross output)	KLEMS-multifactor productivity
Value added	Labour productivity (Based on value added)	Capital productivity (Based on value added)	Capital-labour MFP (based on gross output)	
	Single factor or partial productivity measure		Multifactor productivity (MFP) measure	

Source: OECD Manual.

4. VARIOUS PRODUCTIVITY MODELS

Productivity models are used to measure the Total factor productivity and partial productivities. Various models have been suggested by different authors so as to fit to different productivity measurement scenario such as business level, national accounts or industry level. However all of them should satisfy the basic productivity equation which is defined as productivity = Output ÷ Input. There are some well-known approaches / methods adopted for analysis of productivity. These are stated below.

a) Kendrick-creamer model

Kendrick and Creamer (1955) introduced productivity indices at the company level in their book “Measuring company productivity”. Their indices are basically two types; total productivity and partial productivity. It can be calculated as below.

Total productivity index for given period = (Measured period output in base period price) / (Measured period input in base period price) and partial productivity such as labour, capital or material productivity index can be calculated as; partial productivity = (Output in base period price) / (Any one input in base period price).

b) Craig-Harris model

The next most impartment study using the index approach at the company level is of Craig and Harris (1972-75). They define total productivity measure.

Pt =Qt / (L+C+R+Q)

Where Pt = total productivity, L = labour input, C = capital input, R = raw material input and Q = miscellaneous input and Qt = total output.

c) American productivity center model

American Productivity center has measured that productivity relates profitability and price factor.
The measure is given by Profitability =Sales / cost
= [(output quantity) (price)] ÷ [(Input quantity) (unit cost)]
= [(output quantity) ÷ (Input quantity)] × [(price) ÷ (unit cost)]
= (Productivity) (Price recovery factor)
Where productivity = Output / Input
Price recovery factor = A factor which captures the effect of inflation.

d) Productivity accounting model

H. S. Davis introduced this model. If fulfills almost all the requirements of accounting for productivity. This model takes into account all possible outputs and inputs used, keep out external factors such as price rise etc. Here productivity means total productivity and partial productivity. This can be calculated as below.

$$\text{Total productivity} = \frac{\text{Monetary value of production}}{\text{Monetary value of all input required for production}}$$

$$\text{Partial productivity} = \frac{\text{Monetary value of production}}{\text{Monetary value of any input required for production}}$$

Table-2 shows the benefits and limitation of the various productivity models. From the table it is observed that the productivity accounting model is best suited for the computation of productivity since it avoids the aggregation problem of dissimilar and heterogeneous inputs and outputs by considering the monetary equivalent of output and each input. Although by its very nature the model yields economic productivity and not physical productivity, but the growth profile of economic productivity would follow a similar growth pattern of physical productivity because of the proportional relationship between the monetary equivalent of output

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and the physical quantity of output, the constant of proportionality being the price index. Due to this maneuverability inherent to the model, it is chosen for the computation of productivity for a tea industry.

Table-2. Various productivity model and their benefits and limitation.

Name of the productivity model	Definitiopn	Benefits	Limitation
Kendrick-Creamer model	Total Productivity Index for given period = (Measured period output in base period price) / (Measured period input in base period price) and partial productivity i.e. labour, capital or material productivity index can be calculated as: Partial productivity = (Output in base period price) / (Any one Input in base period price)	Suitable for computing productivity indexes at the company level	Not suitable for the computation of TFP index in case of industries since it does not take into account all the inputs pertaining to industry such as energy, business services etc.
Craig-Harris model	Pt = Qt ÷ (L+C+R+Q) Where; Pt = total productivity, L = labour input, C = capital input, R = raw material input and Q = Other miscellaneous goods and services input, Ot=out put.	Suitable the computation of productivity for firm level and service sector and yields physical productivity	Not suitable for the computation of the TFP status of a tea industry since it does not take into account all the inputs relevant to a tea industry
American Productivity Centre model	Profitability = Sales / Cost = (Output quantity) (Price) / (input quantity) (unit cost) = (Productivity) (Price recovery factor) Where; productivity = output / inputs Price recovery factors = a factor which captures the effect of inflation	Suitable for accounting productivity at the business level and easy to compute productivity with the managerial data like profitability and price recovery factor.	Not suitable industrial use, since productivity measure in relation to an industry considers physical quantity of goods produced which may not be properly represented by profitability which depends on the demand of the goods produced.
Productivity accounting model	Total productivity = (Monetary value of production) ÷ (Monetary value of all inputs required for production) Partial productivity = (Monetary value of production) ÷ (Monetary value of any input required for production)	This model is one of the best models. It fulfills almost all the requirements of accounting for productivity. This model is based on accounting data. It takes into account all possible outputs and inputs used, keep out external factors such as price risk etc. In this model, output means monetary value of production and input means monetary value of all the inputs i.e. material, labour and overhead expenses.	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. this model has got wide applicability both in business sector and manufacturing and service sector

5. PRODUCTIVITY MODEL FOR A TEA INDUSTRY

In tea industry, the following factors of production constitute the input parameters for measuring productivity of the tea industry. They are, 1) Labour input (L). 2) Capital input (C). 3) Material input (R), 4) Energy input (E), 5) Subsidised ration input (S) and 6) Miscellaneous input (Q). The output (Q_t) comprises of the quantity of tea made. Entering these inputs and outputs in the Productivity accounting model we obtain the productivity measurement model suited for a tea industry. The model is shown below

Total productivity = Q_t ÷ (L+C+R+E+S+Q).

In this modified model all values relating to output 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.

The terms used in the proposed model specific to the tea industry are discussed below.

Total Output (Q_t):

The output (Q_t) represents the total sale of made tea in monetary terms.

Inputs to the Modified Model

The input to the modified model consists of labour, capital, material, energy, subsidized ration, and miscellaneous expenses inputs. All the inputs to the model are expressed in monetary terms. Detailed description regarding various inputs to the model is presented below:

i) **Labour input (L):** Labour input comprises the following costs incurred by the tea estate.

a) Wages for development work such as nursery, extension planting, replacement planting, infilling etc.
b) Wages for plucking.
c) Wages for plantation maintenance like drainage, pest and disease control, fertilizer application.
d) Wages for factory workers directly attached to the manufacturing.
e) Wages for indirect factory workers like drivers, electricians etc.
f) Salary of staff.
g) Salary of executives.
h) Overtime wages.
i) Bonus.
j) Employer's share of provident fund.
k) Leave with wages.

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l) Wages for paid holiday.
m) Total medical treatment expenses.
n) Housing maintenance expenses
o) Cost of weather protective such as umbrella, mosquito net etc.
p) Expenses on water supply.
q) Expenses on Creech.
r) Maternity benefit.
s) Gratuity.
t) Fuel and electricity provided to the workers and staff.
u) Others.

ii) **Capital input (C):** The capital input includes the following expenses of the tea estate.

a) Insurance premium for 1) Earthquake. 2) Fire. 3) Accident insurance of executives. 4) Mediclaime of executives. 5) Crop in stock insurance. 6) Crop in transit insurance. 7) Cash in safe insurance. 8) Cash in transit. 9) Other insurance premium.
b) Interest on working capital.
c) Interest on long-term expenditure.
d) Depreciation on plant machineries and other capital assets.
e) Other capital input.

iii) **Material input (R):** This input includes the following costs of the tea estate.

a) Cost of purchased green leaf b) Cost of fertilizer. c) Cost of materials issued from the store. d) Cost of pesticides and weedicides. e) Cost of packing material used. f) Cost of irrigation equipment. g) Other material cost.

iv) **Energy input (E):** Energy input includes the following expenses of the tea industry.

a) Consumption of energy in the factory, which includes 1) Cost of HSD. 2) Cost of furnace oil. 3) Cost of Coal. 4) Cost of tea drying (TD) oil. 5) Cost of electricity.
b) Consumption of energy other than factory.

v) **Subsidized ration input (S):** This input includes the following costs.

a) Cost of subsidized ration issued to the worker, b) Cost of subsidized ration issued to the staff.

vi) **Miscellaneous input (Q):** The expenses relating to the following heads are considered as miscellaneous input (Q) to the productivity measurement model.

a) Various contract work. b) Purchased repairing. c) Security cost. d) Head office expenses. e) Social overheads. f) Demurrages. g) Loading and unloading charges. h) Telephone and charges. i) Legal cost. j) Traveling and transportation expenses of staff. k) Accommodation and messing charges of guests. l) Infrastructure maintenance like road, bridge etc. m) Other overhead. n) Taxes and levies input o) Transportation input.

6. THE CASE STUDY

In this section a case study of Rosekandi tea estate, situated near Silchar in the Cachar district of Assam, India is presented. The factory produces Cut-tear-curl (CTC) category of tea. The process of tea manufacturing consists of different energy intensive unit operations namely withering of green leaf, processing (CTC / rolling), fermentation, drying, sorting and packaging. Figure shows the simplified block diagram of tea manufacturing process.

The case study is presented in order to illustrate how the proposed productivity model presented above can be implemented in the computation of total factor productivity for a tea industry and other partial productivities.

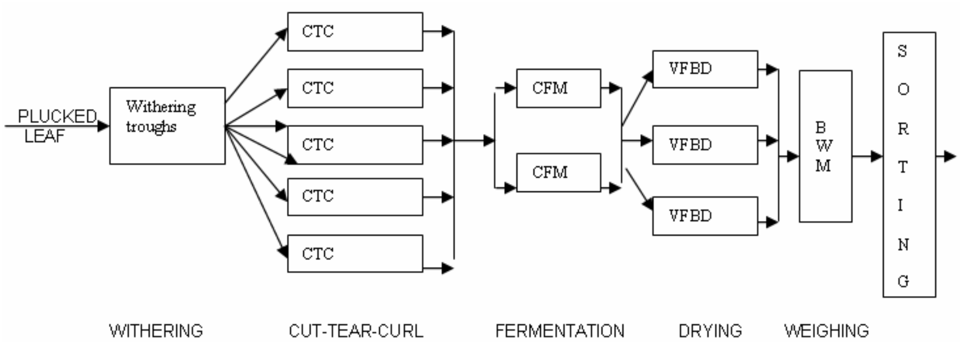

Figure-1. Simplified block diagram of tea manufacturing process practiced in Rosekandy tea estate.

Implementation

At the beginning of implementation extensive data were collected from the Rosekandi tea estate for five year period with effect from 2003 to 2007. The data originates from the office records maintained by the tea estate office as well as the records pertaining to various production parameters and process data kept in the factory. Truely speaking all the necessary data was available to the management.

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The next step was to decide how to measure the output. Though the use of monetary equivalent is inherent to the model, the real problem lies in the taking care of quality issues. In other words the output measurement should take into account the quality of the product. The problem was overcome by deflating the output prices to the base year using inflation rate published by the Labour Bureau, India. The year 2003 is taken as the base year. The monetary equivalent of output is calculated by multiplying the quantity of made tea (output) expressed in kilogram with the price per kg of made tea in the concerned year deflated to the base year. The monetary equivalent of tea made computed in this way truely represents variation of quantity and quality of the product.

Once the output is measured, all the six inputs are measured in the same fashion. Table-3 summarizes annual consumption of six resources (input) and output (tea made) for the five years under study. Table-4 shows the percentage share of different inputs in total input. From these data partial productivities with respect to each of the six inputs computed for each year along with the corresponding annual total factor productivity and are presented in Table-5. Labour productivity was measured by the ratio of output over labour input. Material productivity was measured by the ratio of output over material input. Capital productivity was measured by the ratio output over capital input. Capital input was expressed as sum of depreciation, operative interest, premiums and other capital expenditures. The cost structure for different measurement periods was easy to achieve, because the traditional accounting regularly produces the necessary information. Since static productivity ratio only tells us what happened in a particular year, to compare the static productivity of one period (base period) with the static productivity ratio of the current period we require to compute the total productivity index (TPI) which is defined as follows [3]:

TPI = [(Total factor productivity of the current year) ÷ (Total factor productivity of the base year)] × 100

The resultant productivity indices can be relied upon to monitor progressive changes in productivity. In a similar fashion the respective partial productivity indices are computed with respect to all the inputs considered. In other words these productivity indices portray the relative productivity levels from 2003 to 2007. Table-6 shows the relative productivity level from 2003 to 2007.

7. DATA ANALYSIS AND DISCUSSION

From Table-6, we observe that the relative level of total factor productivity (TFP) of the tea estate remains same for the year 2003 and 2004, after that it shows a downward trend to return almost to its original level in the year 2007. We know TFP changes owing to two factors a) shift in the production function or shift in the state of technology and b) change in efficiency in terms of disembodied technical change. Now, since there was no reported shift in the production frontier during the period under consideration the observed decline in the TFP level must be due to inefficiency in the production procedure. Now, productive efficiency encompasses two aspects a) Technical efficiency which strives for obtaining maximum output from a given set of inputs and b) allocative efficiency which strives for optimal input balance in terms of input prices.

Table-3. Annual output and consumption of resources in Rosekandi tea estate.

Year	Labour input, L (Rs)	Material input, M (Rs)	Capital input, C (Rs)	Energy, E (Rs)	Subsidised input (S)	Miscellaneous input, Q (Rs)	Total input (Rs)	Total output, Q_t (Rs)
2003	24337963	13676139	516201	10294786	303414.8	7265774.14	56394277.7	93508148
2004	29160368	10196868	292600	10435346	294511	5977247	56356941	93883452
2005	28709174	31125269	71650	11597429	278084	5166081	76947688	99850588
2006	31456984	15499059	7511	11452506	245349	4709300	63678656	95569308
2007	34292687	18961471	168590	11874402	251103	4709803	70258058	112212648

Table-4. Percentage share of different inputs in total input from 2003 to 2007.

Year	Labour input, L	Material input, M	Capital input, C	Energy, E	Subsidised input, S	Miscellaneous input, Q
2003	43.16	24.25	0.96	18.26	0.54	12.89
2004	51.74	18.09	0.52	18.52	0.52	10.61
2005	37.31	40.45	0.09	15.07	0.36	6.71
2006	49.40	24.34	0.01	17.98	0.39	7.40
2007	48.81	26.99	0.24	16.90	0.36	6.70

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Table-5. Total and partial productivity ratios on yearly basis from 2003 to 2007 for Rosekandi tea estate.

Year	Labour productivity	Material productivity	Capital productivity	Energy productivity	Subsidised productivity	Miscellaneous productivity	Total factor productivity
2003	3.84	6.84	181.15	9.08	308.19	12.87	1.66
2004	3.22	9.21	320.86	9.00	318.78	15.71	1.66
2005	3.47	3.20	1393.59	8.61	359	19.33	1.30
2006	3.04	6.12	12724	8.34	389.52	20.29	1.50
2007	3.27	5.92	665.59	9.45	446.88	23.82	1.60

Table-6. Relative productivity levels from 2003 to 2007.

Productivity	2003	2004	2005	2006	2007
Labour productivity index	100	83.85	90.36	79.17	85.16
Material productivity index	100	134.65	46.78	89.47	86.55
Capital productivity index	100	177.12	769.30	7024	367.42
Energy productivity index	100	99.12	94.82	91.85	104
Subsidised ration productivity index	100	103.44	116.49	126.39	145
Miscellaneous productivity index	100	122	150	157.65	185
Total productivity index	100	100	78.31	90.36	96.38

Since the industry has not invested in major capital investment during the period under study such as purchase of energy efficient vintage of equipment, installation of mechanized material handling machines, reflected from the negligible share of capital input in the total input as seen from Table-4, the old vintage of equipments has started showing their declining efficiency level which is partially responsible for the declining trend of TFP. To explore the causes of poor productive efficiency we have to move to the partial productivity level. Three major inputs such as labour, material and energy which form 85% to 92% of the total input for the years studied has followed a general declining trend in their productivity indices during the entire period as depicted in Table-6. This establishes that the efficiency in the utilization of these major inputs has gone down causing apparent encouraging trend in capital productivity level as a result of input substitution effect. So this productivity study reveals that the causal factor for the productivity decline in the Rosekandi tea estate is the poor resource utilization of major inputs namely labour, material and energy. Under the existing state of technology following avenues are suggested for the overall improvement of productivity.

a) Labour productivity may be improved by improved work method. Proper method study and job design can produce excellent results. Redesigning the plant and activity can reduce the waiting time and travel distance.
b) The material input for the tea estate mainly comprised of packing 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 at 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 weedicides. Moreover switching over from chemical fertilizer to organic manure will protect the environment of the tea estate. The tea estate management is also suggested to search for a cheaper supplier of packing material. Further, the management may go for new plantation in the vacant land of the estate to curtail the expenditure incurred in the purchase of extra green leaf from the outside agency.
c) Re-engineering of the plant so as to achieve optimal balance of input mix in terms of minimum input cost, improved operating procedure, reduction of losses, recycling of hot flue gases, reuse of hot and high velocity air, learning by experience can improve energy productivity without capital investment.

8. EVALUATION OF THE PRODUCTIVITY MODEL

There are several criteria for the evaluation of any measurement system by measurement theory. The appropriateness of the proposed productivity model is evaluated with the help of the following six criteria. They are a) Validity, b) Completeness, c) Comparability, d) Inclusiveness, e) Timeliness and d) Cost-effectiveness.

Validity

Validity is defined as the ability of a measure to measure what it is intended to measure [12]. Here our objective was to measure the total productivity of the tea estate. So the question is whether the model measures the total productivity of the tea estate or something else? As

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we have computed the output to input ratio with the help of the model, validity of the model is established beyond doubt.

Completeness

Completeness is the thoroughness with which output delivered and all inputs or resources are measured and included in the productivity ratio. The productivity model included the only one output (made tea) and all the inputs that is labour, capital, energy, material and miscellaneous inputs and thus it reflects the overall productivity performance of the industry.

Comparability

Productivity between two periods is a relative measure. The output or inputs measured in the tea estate can be compared if the prices or costs are free from inflation or other external factors. However, when the price or cost change or the product variety changes, the productivity measure has less significance. In case of price rise, the monetary value of the output will rise, even if nothing changes and the productivity index will indicate a false increase. Since the proposed productivity model uses inflation adjusted output and input price any increase in the monetary value of the output for the same quantity will reflect the increase in the quality.

Inclusiveness

The productivity model not only takes care of the production activities but also includes other activities such as quality, purchasing etc.

Timeliness

On timeliness the model can be used for the measurement productivity with higher frequency and can reveal any problem and action could be taken as soon as it was required.

Cost-effectiveness

Cost-effectiveness is defined here as the practicality or the benefit-burden ratio of the measurement. In other words is the measurement worth the effort expended? It is closely connected to the relevance of the measurement. If the measurement or the success factor being measured is not relevant, the measurement is certainly not cost-effective or practical. According to common knowledge, the total productivity is one of the main factors effecting to the profitability and overall competitiveness. Therefore the proposed productivity model measures a value which is useful to the user (i.e. relevant) and hence cost-effective.

9. CONCLUSIONS

The essence of performance measurement in general is to produce useful information with reasonable effort. Measurement methods should not be too complicated to serve the very practical needs of the management. The approaches used in academic studies are not suitable for managerial purposes keeping in mind the traditional nature of work culture prevailing in Indian tea industries in particular, where the dearth of trained person having competency to use the complicated productivity models of research interest is prevalent. However the productivity model should satisfy the criteria of validity, completeness, comparability, timeliness, inclusiveness and cost-effectiveness. The model proposed for the productivity measurement of a tea industry is user friendly and qualifies the above referred criteria. Also, the model has identified the problem areas of poor productivity performance of the tea industry and accordingly some practical remedial measures have been suggested. So, it can be concluded that the study has achieved the objectives earmarked at beginning of the paper.

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