Chapter Two

REVIEW OF LITERATURE

This chapter presents a critical overview of significant studies in the field of measurement of productivity and efficiency and its empirical applications in the tea industry. Applications of measurement of efficiency and growth of partial and total factor productivity in the fields of agriculture and allied activities are also reviewed. Selected influential and significant studies on the plantation sector in both India and abroad are reviewed to set the tone for the present research undertaking. Selected studies on total factor productivity growth in the manufacturing sector are also reviewed. Over the years a significant number of studies have been conducted on spatial and inter-temporal variations in manufacturing sector performance and productivity all around the world including India. However, systematic panel data studies on productivity analysis and efficiency analyses, including TFPG, production and cost frontier estimations (using either stochastic production frontier or DEA) in the tea industry in Assam are rare (Hazarika and Subramanian 1999). A brief review of literature is presented in this chapter which is subdivided across two principal themes, namely, review of empirical studies on productivity and efficiency in plantation and manufacturing and that of empirical literature on tea industry in India and abroad.

2.1 Review of Empirical Studies on Productivity and Efficiency in Manufacturing

Ever since the celebrated contributions of Solow and Swan in the field of macroeconomic growth in 1957, and the consequent development of empirical growth accounting methods during the 1960s and 1970s industrial economists in the west have taken TFPG measurement at the industry level as a very powerful analytical economic tool for framing credible and effective industrial policies. India is no exception in this regard. Numerous influential studies have been conducted on India's large and small scale industries since the early 1970s. These studies mainly use ASI and CMIE data bases.

Hashim and Dadi (1973) estimated the Cobb-Douglas Production function for the large scale Census sector of Indian manufacturing sector over two periods: 1946 to 1964 and 1953 to 1964. Their estimate suffers from problems of multicollinearity among the explanatory variables, i.e. labour, capital and time trend. The coefficient of labour is not significant different from zero in the first period, while those of labour and capital were not significantly different from zero in the second period. Although coefficient of time trend variable was positive and significant in both the periods, being 0.025 and 0.031 respectively, this coefficient showed the joint impact of time and other explanatory variables in the equation.

Banerjee (1973) estimated elasticity of substitution between capital and labour for five selected Indian industries viz; cotton and jute textiles (1946-63), sugar (1946-62), paper (1946-58) and bi-cycle (1946-58). The five different variants of SMAC relationship have been used to estimate elasticity of substitution from time series of inter-state cross section data. It has been observed that the hypothesis of zero elasticity of substitution implying fixed input coefficients was rejected conclusively for all the industries excepting papers. In none of the cases, however, the hypothesis of unitary elasticity of substitution was conclusively rejected.

Mehta (1974) has estimated Cobb-Douglas and CES production functions for Indian sugar industries on the basis of time series data. The CMI and ASI data for the period 1953-65 have been utilized for analytical purpose. The study revealed that total factor productivity has been declining over the period under investigation and thus, growth of output in sugar industry was attributed mainly to increase in capital per employee. The study also observed that there was an evidence of constant returns to scale for the industry and there was no evidence of neutral technical progress for the industry. The elasticity of substitution between capital and labour has been observed to be low (0.54) which was significantly different from unity as well as zero. This result implied that there was evidence in favour of CES production function in Indian sugar industry.

Banerjee (1975) examined the relationship between capital intensity and productivity in the context of Indian industrial development. The analysis has been carried out for manufacturing sector as a whole and five individual industries (viz. cotton textiles, jute textiles, sugar, paper and bicycle) by using CMI and ASI data for the period 1946-64. The study highlighted that the performance of the manufacturing sector was sluggish over the period 1946-64. While labour productivity showed a significant upward trend, no evidence was found to indicate the presence of 'technical progress' in the sector. The hypothesis of constant returns to scale was not rejected. It has been found that elasticity of substitution between capital and labour seems to be unity in all the industries.

One of the most celebrated works on total factor productivity growth in the context of Indian industries was conducted by Ahluwalia (1985). She estimated Solow and Translog indices of TFPG at different levels of industrial disaggregation for the period 1959-60 to 1980-81 with two sub-periods 1958-65 and 1966-80. She made four alternative estimates of TFPG for the entire manufacturing sector and for use based and input based classification of industries. Her study reveals declining TFPG during the first and second sub-periods, interpreted as decline in productivity performance.

Goldar (1986 a) analyzed for the growth of TFP in Indian industries during the period 1951-79. He has presented two sets of estimates pertaining respectively to the period 1951-65 and 1959-79. Also, the productivity experience of small scale sector for the period 1960-78 has been examined. Analysis of productivity trends at a disaggregated level has been undertaken for five broad industrial groups (textiles, metals, chemicals, engineering and other industries) for the period 1951-65 and for 37 major three-digit code industries for the period 1960-70. Inter-industrial differences in productivity growth during1960-70 have been analysed using a multiple regression framework. The estimates of productivity for the two periods 1951-65 and 1959-79 brought out that TFP growth in Indian manufacturing under 1951-79 has been rather sluggish and relative contribution of TFP growth to output growth quite small. Productivity estimates for the small scale sector indicated that in regard to TFP growth, the performance of the small scale sector was not much better than that of large scale sector. Analysis of productivity trends at a disaggregated level revealed marked inter-industrial differences in productivity growth. Thus, the performance of industries critical for industrial development was unsatisfactory. Estimates of Cobb-Douglas production function and SMAC form of CES production function seems to favour the assumption of constant returns to scale, implicit in TFP indices. Estimates of the rate of technological progress, obtained from production function estimation, were broadly consistent with results based on TFP indices, especially in terms of direction.

Goldar (1986 b), made an attempt to study the pattern of TFP growth in Indian manufacturing at the two-digit industry level and provide an explanation of the inter-industry variations in TFP growth using a multiple regression framework. He, also seeked, in particular, to assess the effect of import substitution and industrial concentration on TFP growth. He observed that TFP growth rates vary substantially across industries. For explaining inter-industry variations in TFP growth, the five explanatory variables have been used: (i) output growth, (ii) relative contribution of import substitution in output, (iii) concentration ratio, (iv) rate of change in concentration ratio, and (v) man-days lost in industrial disputes per employee. A significant positive relationship was found between TFP growth and output growth and a significant negative relationship between TFP growth and import substitution. He observed that it seems from the regression result that a 1 per cent higher growth in output was associated with about 0.5 per cent higher growth in TFP. Further. A 10 per cent higher contribution of import substitution to change in output was associated with about 0.6 per cent lower annual growth rate in TFP. Regression results also indicated that in a more concentrated industry the rate of TFP growth tends to be lower and a higher rate of change in concentration ratio (picking up size related efficiency gains) is associated with a higher rate of TFP growth. He concluded that competition and exploitation of scale economies are two important causes of TFP growth. The development strategy should be such that domestic producers face strong competition and are allowed and induced to set up plants enough to exploit scale economies.

Little, Mazumdar and Page (1987) have estimated a three input Translog Production function for five Indian industries, namely, printing, machine tools, soap, shoes and metal casting. They have taken value added as output and capital, skilled labour and unskilled labour as three inputs. They estimated the production function from cross-sectional data on firms obtained from a survey of industrial enterprises in India (belonging to the five industries mentioned above). The sample size varied from 45 in the case of metal casting to 99 in the case of shoes. The Translog Production function and the share equations for skilled and unskilled labour have been jointly estimated on the basis of multivariate regression technique. The share equation for capital is dropped since one of the share equations of has to be dropped to obtain non-singularity of the system. It has been assumed that the disturbance term in the production function and share equations are stochastically independent, so that the technique of iterative multivariate regression will yield maximum likelihood estimates of the parameter on convergence. The results of the study Little et. al, showed that capital, skilled and unskilled labour are mutually substitutable. Generally, the substitution possibility between capital and skilled labour was found to be more than that between capital and unskilled labour. The results did not indicate any significant economies of scale. In soap, metal casting and machine tools the hypothesis of constant returns to scale was not rejected by the data. Printing and shoe making industries exhibited variable returns to scale which was not significantly different from one.

Baruah (1987) used Cobb-Douglas and CES production functions to estimate the returns to scale and elasticity of substitution parameters of 12 selected manufacturing industries of Assam using ASI data for period 1966-79. It has been observed that increasing returns to scale prevailed in the industries like tea manufacturing, wood products, jute products, basic metal industries and miscellaneous chemical products. On the other hand, industries like petroleum products, metal products except machinery and electrical, transport equipments and printing industries were found to be operating under decreasing returns to scale. The results for the food manufacturing, cotton textiles and electricity were inconsistent and inconclusive. The estimation of Kmenta approximation of CES production function highlighted that food manufacturing, petroleum products, cotton textiles, wood products, basic metal, metal products except machinery and electrical, transport equipments, printing and miscellaneous chemical products industries possessed an elasticity of substitution not significantly different from unity. However, tea manufacturing and jute products industries displays extreme values of elasticity of substitution having lowest (less than 0.1) and highest (more than 0.6) values respectively.

Ahluwalia (1991) analyzed the TFPG performance of Indian manufacturing sector at a detailed level of disaggregation (for 63 industry groups of manufacturing at one level and for use- based sectors, i.e. intermediate goods, consumer non-durables, consumer durables and capital goods at another) by using ASI data for the period 1959-60 to 1985-86. The analysis of Translog index of TFPG clearly brought out the poor performance with respect to TFPG up to the end of the seventies. She explored a structural break in the TFPG in early eighties which she called a ‘turnaround’ in TFPG behavior. An important feature of the improvement in the TFPG in the first half of the eighties was that it largely reflected improvements in labour productivity. Capital productivity showed neither an increase nor decrease. The consumer goods sector was the leader in the turnaround in TFPG after 1979-80. The intermediate goods sector which was worse in the seventies but showed a significant improvement although its TFPG continued to be relatively low, i.e. 1.4 per cent per annum. The capital goods sector showed a considerable improvement from 1.7 per cent per annum to 3.4 per cent per annum, but the improvement was not statistically significant. The production function analysis based on Translog production function using pooled cross-section and time series data showed that there has been negligible and insignificant growth in TFP in manufacturing sector over the period from 1959-60 to 1982-83 and there was evidence of a distinct upward shift after 1982-83. The estimates for the sector as a whole also suggested that the returns to scale are not constant and the technical progress had a capital-saving bias. Among the use-based sectors the hierarchy of TFPG remained much the same as with the growth accounting estimates, the two larger use-based sectors (i.e., intermediate goods and consumer non-durables) performed much worse than the two smaller sectors. The upward shift in TFPG was established for all the sectors except capital goods. Technical progress was found to be Hicks-neutral in intermediate goods and capital-saving in consumer non-durables and capital goods. In consumer durables, however, there was evidence of the emergence of a capital using bias in the eighties. Ahluwalia listed improvement in the infrastructure sectors and reorientation in the policy frame as significant factors behind the turnaround in productivity growth in the eighties.

Goldar and Makhopadhyay (1991) used cost price approach of Conrad for analysing substitution among labour, capital and energy in five selected (energy-intensive) Indian industries, namely, cotton textiles, cement, paper, non-ferrous metals and iron and steel. The study was confined to the period from 1951-82. The functional form was taken as Cobb-Douglas in cost prices. Conventional translog cost function estimates have also been provided for comparison. The result indicated that cost-price model provides a high degree of boundedness among inputs. A strong K-L, K-E and L-E binding was found for all the industries. The estimated Allen elasticities of substitution and price elasticities obtained from the cost-price and translog models were found to differ substantially. In this regard, the results were different from the results of Conrad and Olsen-Shieh who found the Allen elasticities of substitution (AES) obtained from the cost-price model by and large similar to such estimates obtained from the translog model. One point of similarity between the results that have been obtained from the two models was that the Allen elasticities of substitution (AES) between labour and energy were found to be positive for all the five industries. This was indicative of a substitution relationship between labour and energy. Another important finding of this study was that the own price elasticities obtained from the cost-price model are low in relation the estimates that has been obtained from the translog model.

Bhavani (1991) analysed the possibilities for substitution of labour for other factors, namely, capital and other material in the modern small scale sector. The study was confined to three metal product industries: (i) steel trunks, (ii) structural metal products, and (iii) bolts and nuts. The data for the selected industries have been drawn from the Census of Small Scale Industrial Units, 1973. The results showed that capital and labour inputs are found to be complementary to each other in two industries, namely, steel trunks and structural metal products. It has been also found that material is a substitute for capital and labour. The magnitude of own price elasticity of demand for labour was observed to be highest among the three inputs in the metal product industries. Both the substitution elasticity and price elasticity of demand varied across size classes within each of the industry. The policy implication drawn from the results is that selected metal product industries belonging to the modern small scale sector are not employment generators in the sense of substituting labour for other inputs.

Ghosh and Neogi (1993) examined the performance of twenty-nine 'sunrise' Indian industries in terms of labour productivity to capital intensity. They tried to study the effect of technology advancement as reflected in strictly rising capital intensity on the productivity of labour. The study used ASI (Factory Sector) data for the period from 1974-75 to 1986-87. The following observations were made by authors on the basis of empirical analysis: (I) increasing use of overhead capital has not produced any significant improvement in productivities, (II) whether one considers skill personnel or just production workers in the definition of labour, in both cases, the downward shift of productivity locus suggests that inefficient use of resources has become the order in Indian 'sunrise' industries in recent years, (III) the most important factors that influence productivities in an aggregative sense are skill, the capital-labour ratio, and/or electricity; interestingly, firm size does not play any significant role in determining productivity.

Balakrishnan and Pushpangadan (1994) raised the question on the validity of TFPG estimates obtained on the basis of single deflation method of measurement of real value added. They argued that the single deflation method of real value added yields bias in the estimates of TFPG especially in the presence of non-constancy of index of relative price of raw materials. In order to construct an index of materials input, a series of weighted average of wholesale prices of 19 major inputs has been constructed; the weights have been calculated from the matrix of input-output transactions published by the Central Statistical Organisation (CSO). They rejected the presence of the phenomenon of ‘turnaround’ in the TFPG in the early eighties as forwarded by Ahluwalia (1991). Their estimates of TFPG for aggregate Indian manufacturing sector for the period of 1970-71 to 1988-89 which were based on the double deflation method of measurement of real value added indicated that, contrary to what is believed, productivity growth in the 1980s may, actually, have been slower than in the earlier decade.

Based on ASI data for the period 1974-75 to 1988-89, Coondoo, Neogi and Ghosh (1993) observed that capital intensity has been rising at a pace faster than that of labour productivity in Indian manufacturing industries. According to this study the rise in labour productivity was the result of rising capital intensity and not due to poor productivity increase

Choong and Tham (1995) measure the rate of growth in total factor productivity (TFP) and its contribution to the growth of the manufacturing sector in Malaysia. Using the Divisia index approach, the results of this study indicate that the rate of growth of TFP averaged at 0.64 per cent per annum between1986-90. Further the average contribution of the growth in TFP to the growth of the manufacturing sector is only 4.67 per cent for the period of this study. The major contributor to manufacturing growth was found to be the growth in intermediate inputs.

Pradhan and Barik (1999) carried out estimation of TFPG is with the help of translog cost function. The empirical findings indicate that both scale economies and technical change have registered a declining trend in recent years producing in the process a declining TFPG. There exists, therefore, a good case for prescribing policy measures that lead to better exploitation of economies of scale and technical change in India.

Ramaswamy (1999) observed that the growth of labour and total factor productivity (TFPG) is to be higher during the deregulation period of Indian manufacturing. The study uses data on 42 three-digit manufacturing industries. The study found that increasing effective rates of protection was not associated with lower TFPG. The study tests the hypothesis that higher degree of trade protection induces greater entry of plants. This hypothesis is statistically supported. The econometric estimates found a positive association between net entry and TFPG, after controlling for inter-industry differences in effective protection, asset size of plants and demand growth. The results support the proposition that competition positively contributes to TFPG during deregulation.

Onjala (2002) examines productivity sources in the manufacturing and agricultural sectors using aggregated data over 1960–1995. Productivity is explained by: growth by factor inputs, and change in total factor productivity. Agriculture is seen as a dynamic sector producing important linkages with the growth of other sectors. The manufacturing sector, on the other hand, is important in growth-oriented analysis, which generally perceives it as crucial for increasing the rate of growth for the whole economy. The study establishes the direction of the links between TFP change in these sectors with trade policy episodes such as imports, export penetration and trade volume.

Chattopadhyay (2004) examines the overall industrial scenario of West Bengal for the past three decades. The paper studies the productivity of capital and labour for the two digit industry groups and the total factor productivity (TFP) of the manufacturing sector of West Bengal as a whole *vis-à-vis* all-India and also for some selected groups of industries for West Bengal. West Bengal has lost its earlier status of one of the highly industrialized States of the country. Its share to all-India net value added, share of employment and factories has come down drastically. Profitability of total manufacturing sector has gone down. Productivity of capital of the manufacturing sector has declined, while labour productivity has increased. However, the latter has increased mainly due to a few industry groups, which are highly capital intensive and have contributed around 85 per cent of the profit of the total manufacturing sector. TFP of the West Bengal manufacturing sector as a whole has been declining, while it has been increasing in case of India. TFP of six industry groups which played a dominant role during the early 1960s has gone down except Jute industry, which itself is a dying industry. That means no new industry groups have come up to take up the position of these industries, which have been performing badly. Therefore, while the State of West Bengal has shown an impressive improvement in case of rural sector, industrial slowdown has not been arrested as yet in the State.

Ranjitha and Mruthyunjaya (2005) assess the contribution of agricultural research in India to increases in productivity. The TFP decomposition method was used to estimate returns to investment in agricultural research between 1964 and 1992. A double log regression framework was used to estimate the contribution of various factors — research, extension, infrastructure, human capital, and weather — to TFP growth. Research and extension stocks were constructed with appropriate lags. There were fluctuations in TFP indices during the study period. There was a fall in TFP index corresponding to the years of natural calamities. The growth rate of TFP has been falling over the years.

Kumar and Jha (2005) present a disaggregated perspective on changes in TFP across states in India. This perspective is valuable since the states are the units of development and policy action in India. The study also examines how changes in TFP will affect the possibility of generating an exportable surplus of rice. This study uses the Divisia-Tornqvist index to compute total output, total input, TFP, and input price indices for crop by state, using state averages of cost of cultivation data for principal crops, collected under the Comprehensive Scheme for the Study of Cost of Cultivation, Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. The study concludes that there has not been much technical change in marginal areas. Deceleration in TFP growth has been observed.

Mittal and Kumar (2005) estimate TFP for wheat in different time periods across different states. This perspective is valuable because states are the units for development and policy implementation in India. Implications of technology change on the real cost of production are examined and the sources of productivity growth are identified. Marginal rates of return to public investments in wheat research are also computed.

Dash, Kabra and Singh (2010) estimate the total factor productivity growth of the manufacturing industries of different states of India using the translog production function to know the structure and growth of registered manufacturing factory sector, examines the extent of employment concentration in Orissa's manufacturing industries relative to all India, to explore the sources of output growth in manufacturing industries. The total factor productivity as the measure of productivity is defined as the difference between the rate of growth of output and rate of growth of combined inputs. They have considered two inputs labour (L), Capital (K) and time (T) representing technical progress. The same procedure is followed for estimating the production function with all Indian figures. They have also tested whether the excluded coefficients are jointly insignificant. They have estimated the average annual TFPG. They have used two estimates of output namely (i) Single deflated gross value added and (ii) Double deflated gross value added. The main findings of their study were: First, TFPG estimates depend significantly on the measurement of output. Secondly, TFPG (Y) and TFPG (Z) remained low and stagnant for a large number of states during 1970s which supports the existing ideas. Finally, productivity of at least three states namely Karnataka U.P. and M.P. have increased during 1990s for both of the two measure of output taken up for the present study.

Elumalai (2011) has estimated TFP of ten major crops grown in the Indian state of Karnataka and analyses its determinants. Growth accounting method of Tornqvist- Index has been used for estimating TFP. The study has relied on Cost of Cultivation data published by the Ministry of Agriculture, Government of India. The study draws motivation from the lack of research evidence to show whether productivity growth in the crop sector has improved post 2000s on account of its widespread slow down or negative growth witnessed during 1980s and 1990s. The analysis confirms that most crops have registered low productivity growth across these periods. Interestingly, during 2000-01 to 2007-08 all crops have showed a positive growth in TFP. Further, the analysis of determinants of TFP indicates that the government expenditure on research, education and extension, canal irrigation, rainfall and balanced use of fertilizers are the important drivers of crop productivity in Karnataka. It is necessary that both public and private investment should be enhanced in agricultural research and technology, and rural infrastructure for sustaining productivity growth in the long run.

Since the early 1990s, several studies have been conducted to estimate the efficiency levels and its determinants in Indian industries and other areas in the organized sector. While some researchers have employed the deterministic production frontier to estimate technical efficiency others have preferred to apply the stochastic frontier. Some researchers have measured technical efficiency on the basis of industry level data in order to make inter industry comparison of technical efficiency. Moreover, some authors have estimated technical efficiency of Small Scale Industries (SSIs) while others have done the same for large scale industries. Page (1984) estimated technical efficiency of selected Small Scale Industries (1979-80) by employing a deterministic frontier with the objective of making intra SSI comparisons of efficiency. He selected shoes, printing, soap and machine tool industries. His finding was that printing and machine tool industries were more efficient than others.

Little, Mazumder and Page (1987) used the deterministic frontier in order to estimate the technical efficiency of selected SSIs. The industries chosen were soap, printing, shoes, machine tools and metal castings. The period considered was identical to that of page (1984). They found that in soap, machine tools and metal casting the additional expenses of employee increases productivity. In all sectors except printing the additional age of capital stock decreases productivity by 2-3 percent.

According to Battese and Coelli (1991), frontier production functions are important for the prediction of technical efficiencies of individual firms in an industry. They presented a stochastic frontier production function model for panel data, for which the firm effects are an exponential function of time. The best predictor for the technical efficiency of an individual firm at a particular time period is presented for this time-varying model. An empirical example is presented using agricultural data for paddy farmers in a village in India.

Kumbhakar (2002) uses a panel-data framework and models firm-specific technical inefficiency which is allowed to vary over time. The specification is flexible enough to accommodate increasing, decreasing, and time-invariant behaviour of technical inefficiency. Time-varying firm- and input-specific allocative inefficiency is also incorporated. The estimation method suggested uses a parametric production function and cost-minimization hypothesis.

Boubaker and Womack (2002) use stochastic production frontier function and farm level data to measure and explain technical efficiency in Missouri Hog production. The study estimates mean technical efficiency for firms in the sample at about 82 per cent, implying that a large proportion of production (18 per cent) is lost due to farm specific inefficiencies. Further, the results of the technical efficiency model prove the effects of technology and managerial skills on the level of production efficiency. The study also finds economies of scale in hog production thus explaining the consolidation in the industry.

Daniel (2003) studies the developments and extensions of technical efficiency measurement using panel data. It primarily focuses on both deterministic (where all observations lie on one side of the frontier) and stochastic (where observations lie on both sides of the frontier) production functions. Discussion of deterministic frontiers is divided into two main approaches: Data Envelopment Analysis (DEA - further broken into three separate subsets according to their assumed returns to scale) and the Free Disposable Hull (FDH). For each of these approaches, output- possibility sets and efficiency degrees in output are given. Further, a comparison between the two approaches as well as a brief discussion on the possibility of statistical inference associated with the deterministic frontiers is presented. The section on stochastic frontiers examines both time invariant and time variant measures of technical efficiency. Each topic includes estimation by Random Effects (RE), Fixed Effects (FE) and Maximum Likelihood Estimation (MLE), with and without the presence of heteroskedasticity as well as discussion on recent developments.

Lindara, Johnsen and Gunatilake (2004) estimated the technical efficiency of spice based agro forestry systems in order to identify the potential increase in production without incurring additional costs for farm inputs. The factors affecting technical efficiency and constraints and potential of the agro forestry system were also investigated. A field survey was conducted covering 120 agro forestry farmers in six divisional secretariats in Matale district during the period of October to December 2002. According to a stochastic frontier production function using a Cobb-Douglas model, hired labour, organic fertilizer, inorganic fertilizer, land size, and soil fertility maintenance cost showed significant positive effects on the agro forestry production. The mean technical efficiency of the spice based agro forestry systems was 84.32 per cent. According to the inefficiency model the efficiency increased significantly as a result of farm visits by extension officers, participation in farmer training, less sloping lands, more experience, and higher diversity of the agro forestry system. Technical efficiency decreased, however, with higher education level of the farmer and with higher off-farm income. Farm income from the spice based agro forestry system is low due to low productivity, market constraints, lack of technology, and institutionally related constraints. Environmental conditions in Sri Lanka are such that a vast number of high value export crops can be grown in the agro forestry system. There is a good possibility for stepping up production of these crops in marginal lands through appropriate crop diversification.

Okoye and Onyenweaku (2007) employed a translog stochastic frontier cost function to measure the level of economic efficiency and it's determinants in small-holder cocoyam production in Anambra state, Nigeria. A multi-stage random sampling technique was used to select 120 cocoyam farmers in the state in 2005 from whom input-output data and their prices were obtained using the cost route approach. The parameters of the stochastic frontier cost function were estimated using the maximum likelihood method. The results of the analysis show that the individual farm level technical efficiency was about 59 per cent.

Jayatilake (2009) applies the Stochastic Frontier Approach to estimate the technical efficiency of tea manufacturing firms in Sri Lanka. The study estimates that the average technical efficiency of the tea manufacturing firms in Sri Lanka is 80 per cent, indicating that there is a potential to increase the production by 20 per cent through efficiency improvement, thereby reduce the cost of production. The results also reveal that the output capacity of the larger factories is higher than that of the smaller factories. The study identifies that the production capacity of tea factories vary between the regions.

Amadou (2007) analyses the factors influencing the technical efficiency of Arabica coffee farmers in Cameroon. To carry out this analysis, a translog stochastic production frontier function, in which technical inefficiency effects are specified to be functions of socioeconomic variables, is estimated using the maximum-likelihood method. The data used were collected from a sample of 140 farmers during the 2004 crop year. The results obtained show some increasing returns to scale in coffee production. The mean technical efficiency index is estimated at 0.896, and 32 per cent of the farmers surveyed have technical efficiency indexes of less than 0.91. The analysis also reveals that the educational level of the farmer and access to credit are the major socioeconomic variables influencing the farmers' technical efficiency. Finally, the findings prove that further productivity gains linked to the improvement of technical efficiency may still be realized in coffee production in Cameroon.

Msuya, Hisano and Nariu (2008) using a stochastic frontier production model proposed by Battese and Coelli (1995), estimates the levels of technical efficiency of 233 smallholder maize farmers in Tanzania and provides an empirical analysis of the determinants of inefficiency with the aim of finding way to increase smallholders' maize production and productivity. Results shows that smallholder productivity is very low and highly variable, ranging from 0.01 t/ha to 6.77 t/ha, averaging 1.19 t/ha. Technical efficiencies of smallholder maize farmers range from 0.011 to 0.910 with a mean of 0.606. Low levels of education, lack of extension services, limited capital, land fragmentation, and unavailability and high input prices are found to have a negative effect on technical efficiency. Smallholder farmers using hand-hoe and farmers with cash incomes outside their farm holdings (petty business) are found to more efficient. However, farmers who use agrochemicals are found to be less efficient. Policy implications drawn from the results include a review of agricultural policy with regard to renewed public support to revamp the agricultural extension system, and interventions towards improving market infrastructure in order to reduce the transaction element in the input and output marketing.

Baten, Kamil and Haque (2009) use a stochastic frontier production function defined for panel data on tea industries, in which the non-negative technical inefficiency effects are assumed to be a function of industry-specific variables and time. The findings suggested that 49 per cent technical inefficiency existed in tea yield. The null hypotheses, that the inefficiency effects are not stochastic or do not depend on the labour-specific variables and time of observations, are rejected for these data. This study also revealed that their existence was a negative relationship between size and yield.

Ismail (2009) analyzes technical efficiency change and technical change for the food-based industry and examines to what extent technical change affects the demand for skills for this industry. Analysis is based on the Manufacturing Survey Data of 1985-2003 at five digits Malaysian Standard Industrial Code (MSIC). The analysis involves two steps; firstly, the use of Data Envelopment Analysis (DEA) Malmquist index to derive technical efficiency change and technical change. Secondly, the estimate of labour demand model using technical change from the first estimation as one of the independent variables. The result from this study shows that technical efficiency change in the food-based industry is still low. Technical change has a significant negative effect on the demand for technical and supervisory workers; and the production workers, but the professional workers are not significantly affected. Therefore, high technology may lead to higher unemployment among the unskilled workers and most unlikely to reduce unemployment rate among the skilled workers who are mostly degree holders.

Edeh and Awoke (2009) employed a Cobb-Douglas stochastic frontier production function to measure the level of technical efficiency and its determinants in improved cassava production. The study was carried out in Abakaliki Local Government Area of Ebony State, Nigeria. A structured questionnaire was used to obtain data from 120 contact farmers sampled through a multistage random sampling procedure. Result showed that the mean technical efficiency of the respondents was 92 per cent, implying that efficiency level could be increased by 8 per cent through better use of available resources. Hence, the farmers did not achieve maximum technical efficiency. Analysis indicated that the coefficients of fertilizer and tractor use were positive and significantly related to cassava output at 5 percent level. The farmer's level of technical efficiency was significantly affected by level of education and farm size. While, the educational level had positive effect, farm size had negative effect on technical efficiency level of the farmer.

Gonzale (2010) applies frontier production function analysis to small farms in Nicaragua during 1998-2005 (Battese and Coelli, 1988). The objective of this study is to estimate an average function that will provide a picture for the shape of the organic fertilizer technology of an average firm (in case of, agricultural production units). Furthermore, a best-practice scenario for organic fertilizer against which the efficiency of the firms within the primary sector can be measured is presented (Coelli, 1995). The results show an acceptable average of technical efficiency which the makers of public policy in Nicaragua a must consider for the future. This is imperative if we consider economy activity indexes that have increased during this period.

Tawfik and Muller (2010) estimate agricultural technology for Tunisian peasants, accounting for the crop choice of peasants and distinguishing inputs for individual crops such as: vegetable farming cereal and fruit-trees. The study employed the use of cross-section data from distinguishable irrigated crops survey conducted on a sample of 218 farmers from 11 regions in Tunisia. The data were collected with the aid of structured questionnaire and were later analyzed. The Cobb Douglass production frontier model is employed in order to analyse data collected. Among the irrigated crop farmers, the significant variables were: farmyard manure, fertilizer quantity, labor, mechanic traction and among of irrigated water applied. The estimated sigma square ($\sigma 2$) and gamma (γ) are widely significant for all irrigated crops and revealed that >85 per cent of the variation in the Tunisian irrigated output among farmers in the study area are due to the differences in their efficiencies. However, we find that predicted technical efficiency widely varies across farms and crops from an average of 54.7 per cent for vegetable farming up to 80.6 percent for fruit-trees. The study also revealed the existing on inefficiency effects among the farmers as: education, farmer's age, irrigation techniques, lack of education, and property of land.

Ghosh and Raychaudhuri (2010) West Bengal and Andhra Pradesh are two large rice producing states in India. Although both the states have undergone rigorous changes in agriculture, the forms of reform have been very different in these two states. While institutional reforms dominated in West Bengal, in Andhra Pradesh agricultural growth was solely driven by technological reforms. Given this background this paper analyzes the cost efficiency of rice production in these two states. It has examined the trend of cost efficiency and technical efficiency of rice production in the two states for the period 1971-2005 by using stochastic frontier analysis. It is observed that cost efficiency in case of West Bengal was higher during the 1970s and early 1980s but after that from the 1990s Andhra Pradesh is having better cost efficiencies. The technical efficiencies are also similar in both the states.

Thus the states, which have followed different paths of agricultural development, show similarities as far as technical efficiency is concerned. But Andhra Pradesh and West Bengal show that both cost and technical efficiency are below the optimum level which is the real cause of worry. From the above analysis, it seems that there is inefficiency of input in each factor used in both the states.

Shumet (2011) provides new estimates of small holder farmers' technical efficiency and its principal determinants using a rural Tigray micro finance survey data collected in 2009. Both descriptive and econometric methods are used. The hypotheses tests confirm the adequacy of Cobb-Douglas over Translog frontier; the appropriateness of using SFA over OLS; the joint statistical significance of inefficiency effects; the appropriateness of using truncated normal distribution for one sided error; and the increasing returns to scale nature of the stochastic production function. The maximum likelihood parameter estimates showed that except labor all input variables have positive and significant effect on production. The results reveal that number of oxen owned has the highest elasticity, then land, followed by labor and value of farm equipment. The analysis shows that the mean technical efficiency of farmers is 60.38 per cent implying that output in the study area can be increased by 39.62 per cent at the existing level of inputs and current technology by operating at full technical efficient level. The estimated stochastic frontier production function revealed that all determinants (except households' sex, farm size, participation in irrigation, and member to association) have significant effect on efficiency of farmers. The sign of coefficients of determinants is found as the expected, except households' sex. Education of household heads, family literacy, family size, share cropping, credit access, crop diversification, and land fertility are found to enhance efficiency. In contrast, Households' age, dependency ratio, livestock size, and off-farm activity are found to increase inefficiency.

Dhehibi, Bahri, and Annabi (2012) investigated farm level technical efficiency of production and its determinants in a sample of 51 cereal producing farms located in the main cereal production region in Tunisia using a stochastic frontier production model. Empirical findings show that labour input factor appears with a minimal effect on the production. The hypothesis of constant returns to scale is rejected at the 5 per cent level of significance, and returns to scale were found to be decreasing. Moreover, the estimated coefficients in the technical inefficiency model are also as expected. The estimated coefficients of the instruction level of farmer and the rotation, technical variable, are negatives and statistically significant at 5 percent level, which indicates their positive effect on technical efficiency. In addition, results indicated that estimated technical efficiency of cereal production in the sample varied widely, ranging from 52.63 per cent to 94.62 per cent, with a mean value of 77 per cent. This suggests that, on average, cereal producing farmers could increase their production by as much as 23 per cent through more efficient use of production inputs. On a second step, Timmer and Kopp indexes of technical inefficiency were estimated for the same farms using a Cobb–Douglas frontier production function with a composite error term, and a developed relationship between these two indices. Results show that the mean values of the Timmer and Kopp TE indices were over 0.80, but one half of the farms were below 0.80 for the Timmer index and below 0.83 for the Kopp index. The level of inefficiency was found to be related to farm size: small and large farms were shown to be more technically efficient than medium-sized farms. With the given inputs, the production of cereals could be increased by 20 per cent on average through making all farms 100 per cent efficient. Alternatively, inputs could be reduced by 17 per cent on average to produce the same amount of cereal output. Finally, the lower level of efficiency but higher yield and total factor productivity in the medium-sized farms means that more cereals can potentially be produced in these farms. The findings revealed that significant factors related to TFP were age, education level and the share of wheat crops into total cropped area. These results calls for policies aimed at provision of training programs, extensions services. In addition, the encouragement of experienced farmers by applying improved input management on these farms can be recommended alongside appropriate new technologies, especially for wheat farmers.

Goldar (1988) compared the technical efficiency of small scale and large scale industries for thirty-seven Indian industries at the three-digit- level. The study was confined to the year 1976-77. The data for small scale industries related to the aggregate for the units assisted by commercial banks while the data for large scale establishments' related to the ASI census sector. The author presented the estimates of relative labour productivity and relative total factor productivity (relative efficiency) of the modern small scale industries. The findings of the study illustrated that the small scale industries (compared to the large scale establishments) generally have low productivity, high capital productivity, low capital intensity (measured as capital per employee) and low total factor productivity. He inferred that the modern small scale sector is inefficient relative to the large sector in a large number of industries. He also found that relative efficiency of small scale industries varies directly with capital intensity, so that small scale industries cannot be relied upon as source of efficient employment generation. The results of multiple regression analysis to explain the inter-industry differences in relative efficiency showed that relative productivity index is found to be positively related to relative size and the proportion of units using power, and negatively related to the ratio of short-term bank borrowings to inventories.

Krishna and Sahotia (1991) applied flexible production function to 17 four-digit manufacturing industries in Bangladesh, using the firm level panel data of CMI Merge file. This study has several features including the measures of both firm variant and time variant technical efficiency. Fifteen of the 30 industries (17 studied by the Translog Production function and 13 by Cobb-Douglas Production function) experienced no significant acceleration in TFP change. Several suffered from deceleration. The overall picture that emerges is one of stagnation in productivity. Technical efficiency of small firms is lower than the large ones. An exercise to explaining the inter-firm differences and temporal variations in technical efficiency in terms of scale of the enterprise, skill composition of labour force ,capital intensity and material intensity failed because the explanatory power of the regressions is found very low and the explanatory variables have insignificant coefficients for the most of the industries.

Neogi and Ghosh (1994) have found that technical efficiency in Indian manufacturing has been declining over time till the late 1980s Further, Neogi and Ghosh (1998) studied the impact of liberalization on the performance selected industries on the basis of firm level data over the period 1989-94. They concluded that productivity growth and efficiency levels did not improve in these industries to the expectation level during this post-liberalization period. Very similar are the conclusions drawn in more recent studies conducted by Adhikary and Mazumder (2004 and 2005). They show that efficiency levels in the entire manufacturing sector in West Bengal did not rise during post reform years vis-à-vis pre-reform years. They found declining TFPG at the state level during pre-reform years in West Bengal but rising TFPG during post reform years.

Mitra (1995) estimates the time-variant technical efficiency and total factor productivity growth for 17 two-digit industry groups based on the panel data for 15 major states in India. The total factor productivity growth (TFPG) in a large number of industries seems to have improved across most of the states during 1985-86 to 1992-93 as compared with the rates estimated for the period 1976-77 to 1984-85. Technology acquisition, efficient utilisation of resources and infrastructure development are some of the factors which possibly contributed to the increase in TFPG.

Neogi and Ghosh (1998) study the impact of liberalization on the performance of selected Indian industries with firm level data. The performance indicators chosen for this study are growth of value added, capital intensity, labour productivity (partial productivity indicator) and total factor productivity (TFP). The paper also observes the performance of these industries in terms of inter-temporal changes in efficiency from 1989 to 1994. It concludes that productivity growth and efficiency level have not improved as per expectation during the post-reform period and the distribution of efficiency is skewed. However, the time period is not long enough to reach any final conclusion. But such study is needed to review the impact of liberalization on Indian industries for better monitoring of reform policies.

Blaise (2003) examines the economic performance of a large number of African countries using an international comparable data set and the latest technique for analysis. The paper focuses on growth in total factor productivity and its decomposition into technical change and efficiency change components. The analysis is undertaken using the data envelopment analysis (DEA). The study uses data of 16 countries over the period 1970–2001. It was found that, globally, during that period, total factor productivity has experienced a positive evolution in sampled countries. This good performance of the agricultural sector was due to good progress in technical efficiency rather than technical progress. The region suffered a regression in productivity in the 1970s, and made some progress during the 1980s and 1990s. The study also highlights the fact that technical change has been the main constraint of achievement of high levels of total factor productivity during the reference period in sub-Saharan Africa. Contrary to this in Maghreb countries, technological change has been the main driving force of productivity growth. Finally, the results indicate that institutional factors as well as agro-ecological factors are important determinants of agricultural productivity growth.

Okoruwa, Ogundele, and Oyewusi (2007) contribute to the agricultural productivity literature in developing countries and Nigeria especially by quantifying the level of efficiency for sample of rice farmers from North Central Zone of Nigeria. A stochastic efficiency decomposition frontier analysis was used to derive technical efficiency measures separately for rice under two production systems (upland and lowland systems). Average economic efficiency of 51.9 per cent and 55.4 per cent found for up land and lowland rice farmers respectively suggests that there is room for productivity gain for farms in the sample through better use of available resources given the state of technology. Gains in productivity growth have become increasingly important to Nigerians as demand for rice continue to increase due to population increase. Although, all the socio-economic variables tested against efficiency were significant at one level or the other there was no clear strategy of improving the relationship between them. One possible explanation for this finding is the existence of stage of developing threshold below which there is no consistent relationship between socioeconomic variables and productivity. The results suggest that rice farmers can still improve to reach such threshold in Nigeria. Hence, adoption of improved rice varieties, improvements in educational levels would be needed to go beyond this threshold before additional investments in human capital and other related factors.

According to Ali, Singh and Ekanem (2007), economic reforms have brought new opportunities and challenges before food processors in the competitive market environment. To meet the emerging demand for processed food products due to change in consumption preference, there is a need to offer innovative products, which consequently require technological intervention to achieve production efficiency. The paper evaluates the performance of major inputs used in the food processing industry and identifies the determinants of productivity and efficiency changes across various segments. Tea industry is studied at the three digit level of industrial classification. Based on the findings, the paper makes suggestions to be used by policy makers and food processors on various technical issues that can improve productivity and efficiency in Indian food processing industry. The point to be noted is that it is not a TFPG study solely on the tea industry in India.

Shanmugam and Soundararajan (2008) attempts to decompose the agricultural output growth obtained in 15 major states for the period 1994-95 to 2003-04 into the three components (i.e., Output growth by increasing input growth, technical progress and improvement in technical efficiency) using the random coefficients frontier production function model. Results of the study indicate that the efficiency has declined over time for all the states and the average technical efficiency is only 72 per cent. This means that there is a potential to increase the existing output by 28 per cent without increasing inputs. We found that in most of the states, growth was only due to higher inputs. Investment in extension services along with sustained investment in agricultural research and development, and infrastructure is the need of the hour. West Bengal is the most efficient state in applying labor and fertilizer inputs and also has a very high overall efficiency. This can be linked to the successful land reform policies of the state.

Natrajan and Malathy (2008) analyze total factor productivity growth of the unorganized manufacturing sector in India using several rounds of the large scale national sample survey state level data for 15 major Indian states for the period 1978–1979 to 2000–2001. Data envelopment analysis is used to compute Malmquist total factor productivity index and its components. The impact of economic reforms on efficiency and productivity is examined. Evidence suggests that total factor productivity registered a positive growth during the period in the country as a whole. Most states in the country witnessed higher total factor productivity growth in the post 1990s reforms period than in the pre-reforms period. Decomposition of the Malmquist productivity index shows that improvement in technical efficiency rather than technical progress had contributed to the observed acceleration in the growth rate. Econometric analysis of the determinants of total factor productivity growth demonstrates that ownership, literacy, farm growth and infrastructure availability significantly influence total factor productivity growth in the sector.

Ajetomobi (2009) investigates the Total Factor Productivity (TFP) growth in the Economic Community of West African States (ECOWAS) cotton and its decomposition to efficiency change and technological progress from 1961-2005, using the stochastic production frontier approach. Calculations are based on panel data of major cotton producers in the region collected from the Food and Agriculture Organization Statistics (FAOSTAT) database, and the international cotton advisory committee database. The data includes cotton output and six input variables comprising land area, labour, seed, capital, time trend and country fixed effects. The 45-year period is divided into two subperiods—1961-1978 and 1979-2005, in order to study the effects of ECOWAS reforms on productivity growth of the crop. The results show that there is potential for efficiency improvements in cotton production in ECOWAS, and the average technical efficiency score for the region is 0.91. The most technically efficient country is Burkina Faso, noted for sustainable cotton support system. A closer look at the TFP in the ECOWAS and pre-ECOWAS sub periods shows larger TFP in the ECOWAS period (1979-2005). In both the pre-ECOWAS and ECOWAS periods, productivity growth in cotton is sustained through technological progress rather than through more efficient use of inputs.

Raj and Mahapatra (2009) make an attempt to examine the impact of reforms on Industrial sector (both organized and unorganized sector) in India during the reforms period by adopting both partial factor productivity and total factor productivity approach. Further, to identify the role of technical efficiency and technical change, attempt has been made to decompose total factor productivity growth (henceforth, TFPG) into technical change and efficiency change by using Malmquist index.

Jinbo and Zhou (2010) applied the stochastic frontier analysis to study the food production in China by using the panel data of the 30 provinces during 1978-2008. Based on the results of the analysis, they conduct a factor-analysis on the technical efficiency in food production, and a decomposition of the total factor productivity growth. The trend of the components in TFP growth is analyzed. The results show that the infrastructure and institutions in agriculture are two key factors affecting the technical efficiency of food production. Food output growth is mainly enhanced by the growth of the inputs while the TFP contributes little to the growth. The average of TFP growth is only 1.17 per cent. The reason is that the growth in technical progress and that in technical efficiency move in the opposite direction. The velocity of TE growth has been decreasing gradually since 2004 while technical progress becomes a key momentum of TFP growth.

Candemir, Ozcan, Guneş and Deliktaş (2011) measure the production efficiencies and total factor productivity changes by Data Envelopment Analysis (DEA) Approach and Malmquist Productivity Index. The findings of study show that the average annual technical efficiency scores change between 0.841 and 0.938. It has also been observed that there are average annual 1.3 per cent improvements in technical efficiency.

Ozden and Senkayas (2012) analyze the structure of the effectiveness and productivity of Turkish food industry. Statistics on the industry, production, employment and capital were used implementing the Malmquist index, data envelopment analysis (DEA) and partial productivity methods. Production value was considered as output whiles the capital and labour values were considered as inputs. The analysis covers a ten-year-period from 1999 to 2008. The results were displayed according as partial productivity, efficiency, total factor productivity (TFP) and component changes. The results were evaluated after a study on the current state of food industry. Food companies that are generally small and medium sized firms are mostly private sector organizations. The results suggest that private enterprises are much more efficient and productive compared to public ones and technological change is at a sufficient level in both enterprises; however, public enterprises suffer from a decrease in efficiency resulting from scale economies.

Farkas, Maria, Varga and Tibpr (2012) want to show that, though, many sectors of Hungarian agriculture have been operating at low level of technology and efficiency; there was a big expectation about the fast catching up with accession to European Union. This paper investigates the effect of EU membership on the productivity performance of Hungarian agriculture based on the years 2005 and 2009 using Data Envelopment Analyses and Malmquist index. The analysis showed that there were considerable reserves of efficiency in the presented two main branches (wheat and pig fattening) of the Hungarian agriculture, and the reserves slightly decreased in wheat production, but they increased in the pig sector by EU accession. The implication for agricultural reform of future productivity growth has also been assessed.

Balakrishnan, Prathap, Karpagam, Govindaraj and Naidu (2012) examine issues related to the sugarcane productivity, particularly with reference to Tamil Nadu state which has highest yield in India. Data envelopment analysis (DEA) and stochastic frontier analysis (SFA) used to assess productivity growth of sugarcane farming. The results show consistency between the approaches and there are potentials for efficiency improvements. Second, there has been a productivity improvement in the sector, in the interval 0.7–15 percent in the periods studied and technical change had the greatest impact on productivity. The average TFP in after introducing variety Co 86032 was larger than that of pre- introduction of this variety. In both periods, productivity growth is sustained through technological progress.

2.2 Empirical Literature on Tea Industry in India and Abroad

Interestingly it is found that globally studies on technical efficiency, cost efficiency and its determinants in tea production are relatively more common, whereas studies on trends and patterns of total factor productivity growth and/or its decomposition in tea industry are rare. In fact Sivaram's (2000) study focuses on labour productivity trends which are simply a partial factor productivity study and not a total factor productivity growth study. This literature gap in this area justifies the necessity and importance of the present research undertaking.

Bora (1991) developed a system dynamics model in the beginning of the eighties to study and analyse the system behaviour and also to suggest policies for future growth of the Indian Tea Industry. The findings from a Delphi study were used in constructing to the SD model and in formulating policies for the desired future growth industry. The paper makes an attempt to compare the actual growth pattern of the Indian Tea Industry vis-à-vis the growth of other related factors with the predictions made by the Delphi panel lists and those generated by the SD model. The reasons for variations in the growth patterns have also been explored.

Hazarika and Subramanian (1999) analyses the production efficiency of tea estates with the objectives of facilitating the removal of production constraints in the Indian tea industry and particularly in Assam, and helping policy makers to strengthen the production base of the tea industry. A total of 67 estates were selected from two prominent tea growing districts in Assam, viz., Sibsagar and Dibrugarh during the year 1992-93. A stochastic frontier function was used to estimate the farm specific technical efficiency of the estates. The results of the analysis showed that even under existing technology, potential exists for improving productivity with proper allocation of existing resources. Hence extension strategies need to be taken to educate estate owners about the rational use of inputs. The existence of obsolete tea bushes is one of the factors that inhibited the growth of the industry. The high percentage of vacancy and old age bushes weakened the productivity of the plantations. It is concluded that estate owners should be educated on the need for undertaking infilling, replanting and replacement planting.

Chirwa (1999) estimates the level of technical efficiency between 1984 and 1988 using the deterministic production frontier approach by using the census of production data for large establishments in selected manufacturing industries in Malawi .The study uses panel data for seven manufacturing sectors: tea; tobacco; wearing apparel; printing and publishing; soaps, perfumes and cosmetics; plastic products and fabricated metal products. The mean overall technical efficiency ranges from 38 per cent in the printing and publishing industry to 87 per cent in fabricated metal products. However, the minimum technical efficiency scores range from as low as 16 per cent in the tea industry to 55 per cent in plastic products at firm level. The predicted firm level efficiencies are explained by firm specific and industry characteristics. The analysis reveals that the market share of the firm is positively associated with technical efficiency while monopoly power is negatively associated with technical efficiency.

Sivaram (2000) examines recent experience in productivity improvement schemes in South Asia tea plantations, with particular attention to labour productivity. In this study, the author recalls the importance of tea production in Bangladesh, India and Sri Lanka, in terms of employment and foreign exchange earnings. The harvesting of tea leaves is a year-round activity, which is carried out manually, predominantly by women workers. Some mechanization is being tested although so far the results cannot compare quality-wise with hand plucking. The productivity of the harvesters is therefore a prime consideration. The author discusses two main means of raising the productivity. The first concerns the organization of harvesting, with decentralized teams of harvesters working according to a scientifically determined plucking schedule monitored through growing computerization. The second rests on the elaboration of a wage incentive package composed of a base rate plus incentives for extra output. Four different classes of fields, based on average yield of green leaf per month are defined. In particular, he argues in favour of greater emphasis on preventive health care. Water and sanitation are two areas singled out. Proper facilities are shown to have a direct impact on overall morbidity. The author discusses the role of social services, particularly in the provision of childcare facilities, which are seen as essential for the largely female workforce on tea plantations.

Mahesh, Ajjan and Raveendran (2002) analysed the technical efficiency of Indian tea production using data for the year 1998-99 from four districts, viz. Dibrugarh (Assam), Dooars (West Bengal), Nilgiris (Tamil Nadu), and Idukki (Kerala). The sample consisted of 100 corporate units and 100 tea farmers. Results revealed that 13 percent of the total farmers belonged to the most efficient category (91-99 percent efficient) and 68 percent in the least efficient group (64-80 percent efficient), with a mean technical efficiency of 76.62 percent. In the case of corporate units, about 43 per cent belonged to the most efficient category and 37 percent in the least efficient group, with a mean technical efficiency of 84.42 percent. It is concluded that there exists a good scope for improving tea productivity with the proper allocation of existing resources.

Basnayake and Gunaratne (2002) estimated technical efficiency of the tea small holdings sector in the Mid Country Wet Zone of Sri Lanka in order to identify the potential to increase production without incurring any additional costs for inputs. The primary data collected during the period September – January 2001 relevant to sixty small holder tea producers in the Mid-country Wet Zone was used for the study. The mean technical efficiency of the tea small holdings sector in the Mid Country Wet Zone was found to be 64.60 per cent.

Ariyawardana (2003) examined the sources of competitive advantage and studied how it was related to the performance of the tea growers in Sri-Lanka. His study provided a deep understanding of this issue from the management point of view but failed to focus on the efficiency of tea industries. Mahmud (2004) observed that the demand of tea in the market of Bangladesh was increasing 3.5 per cent each year and the supply of tea was increasing only by 1 per cent each year. Saha (2005) studied only on economic analysis of tea industry in Bangladesh. Haque (2006) explained the possibility of alliance among the closely located tea gardens situated in the South-eastern part of Bangladesh. These studies do not adopt with a stochastic frontier analysis for the productivity and efficiency measurement of tea industries of Bangladesh, which is generally thought as an essential analytical analysis for tea industry.

According to Jayasinghe and Toyoda (2004), organic tea is emerging as a major farming activity in Sri Lanka. In this paper, using a stochastic frontier analysis, they analyse the technical efficiency of organic tea smallholdings in the mid country wet zone of Sri Lanka. The Cobb-Douglas functional specifications are found to be an adequate representation of the cross-sectional data obtained in 2002. The results indicate that there is great potential to increase production by 55 per cent through efficient use of the present technology. These results identify a significant relationship between compost application and labour on organic tea production. A significantly positive relationship is also found between technical efficiency and training of farmers. Large numbers of vegetative propagated tea plants in the farm enhance the efficiency. The characteristic crop diversification observed in the organic tea farming system has significantly reduced the efficiency. Finally, a specific policy for the development of the organic tea smallholding sector is suggested.

Manjappa and Mahesh (2008) examines the total factor productivity growth (TFPG) and its components TE (technological progress) and TEC (technical efficiency change) in ten manufacturing industries, classified them into capital-intensive and labour-intensive industries (five in each segment) using annual time series data for the period 1994 to 2004. The TFP growth is estimated by applying Malmquist Productivity Index (MPI) on the panel data of aforesaid segments separately. The study finds that the average TFP growth in the capital-intensive industry segment grew at a moderate rate of 1.7 per cent per annum during the entire study period, whereas, its counterpart, selected labour-intensive industries have shown a productivity regress, it is -0.9 per cent. The decomposition of TFP improvement into technical efficiency change (catching-up effect) and technological progress (frontier shift) reveals that the TFP growth is primarily contributed by technological progress rather than by technical efficiency change in capital-intensive industries whereas in labour-intensive industries low growth of technical efficiency (0.5 per cent) has been offset by a higher rate of decline in technological progress. The results are, by and large, useful for policy makers in designing industrial policies.

Gupta and Dey (2010) 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.

Maity (2011) is of the view that once tea was the major source of export earnings for India, but now India is trailing behind in the field of tea production and exports. Darjeeling tea is considered as India's pride and almost entire production are exported. The depressed tea export of India actually caused the breakdown of the tea industry in West Bengal. Under such circumstances, it is appropriate to verify whether the tea gardens of West Bengal are efficient or not. This is so because efficient utilization of economic resources can reduce the cost of production and thus make the industry more competitive. For the sustainability of the development of the tea gardens of West Bengal, efficient utilization of economic resources is necessary as well as sufficient condition. In this paper, an attempt has been made to measure simultaneously technical and allocative efficiency for large, medium and small tea gardens in West Bengal.

Pradyut (2012) India's tea sector has been faced with serious challenges followed by internal and external developments during the last two decades or so. The depressionary trend in various respects of tea sector has been marked in Assam, which has global reputation in terms of output generation and spread of tea cultivation. It was expected that the period of India's economic liberalization would revive the Assam tea sector. But the reality has been different. There has been a gradual shift in most of the macro variables of tea sector of Assam in particular and India in general, but such changes were only due to trend variable but not due to productivity improvement of land and labour in the state. At the backdrop of this scenario, this paper endeavours to analyze some of the internal factors influencing the production of tea in Assam during the period of economic liberalization. The outcome of the present study reveals that the productivity of land and labour has not significantly improved in the whole period under investigation. Even India's liberalization period has been unable to influence tea productivity in the state significantly. The trend is also expected to continue in the near future, unless suitable method of cultivation, which ensures higher productivity of either land or labour, is undertaken. A comparative analysis of the performance of tea sector of Assam during pre-liberalization and liberalization periods revealed that there was a structural break after initiation of economic liberalization. Judging from the lower compound annual growth rates during liberalization period compared with pre-liberalization growth rate, the study concludes that India's liberalization period has been less successful in reviving the Assam tea sector.

2.3 Research Gap

Justification of the present study is essential. **Firstly**, according to Hazarika and Subramanian (1999), systematic panel data studies on productivity and efficiency analyses (including TFPG, production and cost frontier estimations) for the tea industry in Assam using either stochastic production frontier or DEA are not only rare but are not found at all in the literature on productivity and efficiency in the plantation sector. Perhaps the study cited above is the only study on the efficiency of tea plantations in Assam that is available in literature.

Secondly, studies on technical efficiency, growth of total factor productivity (TFP) and its decomposition, in plantation and farm sector and the question of how to measure them, is an important issue in developing countries' agriculture (Shah, 1995; Hazarika and Subramanian, 1999). Although quite a few econometric studies on technical efficiency and productivity analysis in plantations as tea, coffee, rubber, cocoa, etc. have been conducted globally, too few econometric studies precisely on this issue are available in case of the tea industry in Assam. This highly justifies the necessity and importance of the present research undertaking.

Thirdly, it is found that globally studies on technical efficiency, cost efficiency and its determinants in tea production are relatively more common, whereas studies on trends and patterns of total factor productivity growth and its decomposition in the tea industry in India and Assam are rare. In fact Sivaram's (2000) study focuses on labour productivity trends which are simply a partial factor productivity study and not a total factor productivity growth study. Thus the literature gap in this area needs to be filled justifies the necessity and importance of the present research undertaking.

Fourthly, very few studies are available on time varying technical efficiency in the plantation sector around the world. One reason could be the lack of availability of panel data in plantations and agriculture. Technical efficiency levels of a particular firm may be either improving or deteriorating over time. It also possible that technical efficiency may remain more or less constant over time and may not be time varying. If a firm is seen to exhibit declining technical efficiency then further investigations may be carried out to know the actual reasons behind such phenomenon. Since efficiency is interpreted in a relative sense, falling technical efficiency is synonymous with declining performance of the producer relative to other production units in the cross section. In this context there is another interesting issue. It is known that TFPG and technical efficiency are theoretically different concepts although both depend on the measurement of inputs and output. As a matter of fact high TFPG may or may not be associated with high technical efficiency, the converse being also true. The present study addresses this research gap by studying the association between TFPG and technical efficiency at the firm level.