In this chapter, an attempt is made to review some of the important available works on the problem of farm productivity and efficiency in order to gain deeper insight into the problem. The findings of all works available at this end, carried out by different authors in India and abroad are presented below.

2.1 Production and Productivity Concept:

“Agricultural productivity may be defined as the ratio of the index of total agricultural output to the index of total input used in farm production. It is, therefore, a measure of the efficiency with which inputs are utilized in production, other things being equal” (Sofi, 1984). According to Dewett, (1966), “Productivity expresses the varying relationship between agricultural output and one of the major inputs, like land or labour or capital, other complementary factors remaining the same…. ” He also suggests that it may be borne in mind, that productivity is physical rather than a value concept.

“The connotation of agricultural productivity engaged the attention of many economists at the 23rd Annual Conference of the Indian Society of Agricultural Economics. Some Economists suggested that the yield per acre should be considered as an indicator of agricultural productivity. A number of objections were raised against this view because it considered only land which is just one factor of production while other factors are also responsible, therefore, it was arbitrary to attribute productivity entirely to land and express it as per acre of land. It was suggested, for
instance, that productivity could also be measured in terms of per unit of labour and different regions compared on that basis. It was pointed out farther, that the average returns per unit of scarce resource do not depict the true picture, therefore, instead of it, the marginal returns per unit of the scarce resource should be considered. This definition appears to be more meaningful than others, but gives rise to a lot of practical difficulties. After a thorough discussion, it was generally agreed that the yield per acre may be considered to represent the agricultural productivity in a particular region, and that other factors of production be considered as the possible causes for the variation while comparing it with the other regions”, (Sofi, 1984).

2.2 Important Factors Responsible for Low Production and Variation in Productivity:

“Agricultural prosperity is greatly dependent on two important factors, namely, technological and institutional. The technological factors that affect agricultural growth may be summarized as availability of agricultural inputs in required quantity and quality, methods of cultivation, improved seeds, fertilizers, insecticides, better agricultural equipments such as harvesters, tractors, etc., which help to improve farm productivity even if no land reform measures are introduced. The institutional reforms include the redistribution of land ownership in favour of the cultivating classes so as to involve the peasantry in the upliftment of the rural economy. This also greatly helps in improving the size of farms. Institutional measures like land reforms also help in providing greater security to tenants as also reduction of rents, etc., through tenancy reforms and regulation of rent. It goes without saying that inhibiting factors such as existence of feudal land relations, small size of farms, sub-division and fragmentation of land, insecurity of tenancy rights, high rents etc. are major irritants in the way of raising farm productivity. These factors affect the capacity of the farmers to save and invest in agriculture as also prevent them to
enjoy the fruits of their labour. "The emancipation of peasantry from bondage like forced labour, less than subsistence wages and insecurity of tenancy is bound to release the growth impulses thus rising farm productivity", (Ganguly, N. 1987).

Speaking on the success of Green Revolution, it is observed, “One of the significant achievements in post-independence India has been the green revolution and the phenomenal rise in agricultural production. As a result of this, India has become nearly self-sufficient in food production and we have been able to face the worst drought of 1987-88 successfully. But unfortunately, the gains of green revolution have not benefited much the smaller and marginal farmer. This is mainly because the new agricultural technology requires large investment in terms of improved seeds, costly fertilizers, insecticides and pesticides and the farm machinery (combined with higher risks involved), which generally the small farmers cannot afford” (Dahiya, 1992).

According to Pandit (1965), “Productivity is defined in economics as the output per unit of input.... the art of securing an increase in output from the input or getting the same output from the smaller input”. He farther suggests that for increase in productivity, there should be more efficient use of some of or all the factors of production, viz, land, labour and capital.

Subbaiaha et al. (1988) have revealed in their findings that one of the main reasons for low rice productivity in India is the variation in fertilizer usage between the country’s different agroclimatic zones and between states in each region and they further opined that in recent years the trials conducted reveals that imbalanced nutrient use is the principal cause of the current stagnation in yield levels.
2.2 (a) Irrigation:

Controlled, assured, low cost and continuous irrigation facility is very much essential for a smooth agricultural operation and for achieving higher agricultural production as well as productivity. Realizing the importance of irrigation system, Mahatma Gandhi observed, "Nothing can be more important than the provision of irrigation facilities in all villages in the country, because this constitutes the basis for agricultural growth. In the absence of irrigation facilities, agriculture is nothing more than a gamble". In this direction the Planning Commission (1978) also observed "Success in enlarging the area under irrigation is crucial in raising agricultural production. An efficient irrigated cropping system alone can sustain India's ever expanding population. Irrigation provides food security against the vagaries of monsoon and enables cropping intensity to increase".

Shukla, S. P. and Agarwal, A. K. (1986) propounded that a major concern in the North Eastern Region is its deficiency in the expansion of irrigation facilities. The authors emphatically advocated its development because the intensity of cropping comes to be highly interlocked with the weal and woe of peasantry.

Agarwal, A. K. (1987) opined that after introducing new agricultural strategy irrigation has now become all the more crucial input for attaining higher level of productivity. High yielding variety of seeds requires not only more water but more rounds of irrigation. Further, irrigation helps in inducing multiple cropping and reducing the extent of 'current' and 'other than current fallows' increasing the intensity of cropping.
Hossain, M. et al. (2001) study shows that the main contributors to agricultural growth in productivity are rapid expansion of irrigation and diffusion of modern high yielding rice varieties.

Shah Mahmood and Khair-uz-Zaman (2007) in their analysis indicate that irrigation is the most significant factor affecting crop yield. Its statistical significance shows that irrigation positively changes crop yield and this has been possible due to the availability of irrigation water through the Chashma Right Bank Canal (CRBC). Thus CRBC has played a very significant role in enhancing crop yield.

2.2 (b) Chemical Fertilizers:

Chemical fertilizer is an important factor of agricultural productivity because cultivation of same plot of land year after year causes erosion of soil fertility and to maintain fertility in soil it is necessary to use fertilizers. Application of fertilizer is also very much essential to boost the agricultural production in the country. The following reviews highlight the importance of application of fertilizers for maintaining high agricultural productivity.

According to the FAO (Food and Agriculture Organization of the United Nations), chemical fertilizers are the single most important contributor to the increase in world agricultural productivity over the past 30 years.

Chowdhary, T. K. (1967) observed that the continuous exploitation of the soil in the past without adequate attention to the management of soil fertility resulted in gradual exhaustion of plant nutrients from the land. This remained a major weakness at our agricultural front.
Wang Q. B. et al. (1996) cited that the official Chinese estimate attributes 40 percent of China’s production increase to chemical fertilizer. Farmers also recognize the significant role of chemical fertilizers; according to a 1998 and 1999 survey done in Inner Mongolia; farmers cited chemical fertilizer, followed closely by new crop varieties, as the most important factor that has affected production in the preceding 20 years.

2.2 (c) Technology and HYV Seeds:

Hanumantha Rao, C.H. (1979) opines that the cause of increasing use of tractors in farm operations in Punjab and Haryana is that the tractor is the relatively cheaper input. According to Rao, rapidly increasing population has pushed up the prices of food grains substantially and this factor has accounted for an increase in labour wages (both and cash).

Singh, B. (1985) argued with convincing evidence that the response of agricultural modernization in particular of HYV seeds related technologies in respect of the incidence of poverty depends on the nature of the agrarian structure not just at the level of states but also at the village level as determined by the institutional and social history of the village.

Chandra, N. and Singh, R. P. (1992) conducted study on the impact of new technology adoption on Tribal Agriculture in Bihar. The study was conducted on 160 samples of two districts of Hazaribagh and Ranchi for the agricultural year 1988-89. The study reveals that the study area was characterized by preponderance of low adoption of technology. Among the various determinants of adoption, income from crop, credit orientation of farmers, attitude towards HYV seeds, risk orientation, age of farmers and land owning ratio contributed significantly to adoption of new technology.
Saha, A. (2004) on her paper on the Determinants of Adoption of HYV Rice in West Bengal ascribes that today, while India is a world leader in the production of number of agricultural commodities, its yield levels for most of the crops are nowhere near comparable with what some of the other countries of the time have achieved. One of the main attributes for the low level of yield attained in India is the unsatisfactory spread of new technological practices, including cultivation of High Yielding Varieties (HYV). Contrary to the general perception that the availability of irrigation is a precondition for cultivation of HYV rice, the author asserts that adoption of HYV cultivation even in the absence of irrigation could be profitable relative to the cultivation of traditional rice, if the rainfall is normal. And further points out that the slow progress of HYV cultivation in the 1980s, to the failure of public policy to circumvent agro-climatic barriers of adoption and also to the failure of State extension service system. The author recommends that any process of rural development must address the issue of removing technological barriers in the form of imperfections in the market and put in place an efficient network of distribution.

2.2 (d) Education and Agricultural Productivity:

The level of education of farmers is a strong indicator of quality of human resources engaged in cultivation. The adoption of new technology depends upon the level of education of the farmers. The importance of educational level of the farmers can be derived from the following review of studies conducted by the different experts of economics.

Education enhances the farmers' capacity to maximize the perceived profit function by allocating the resources in a more effective cost-efficient manner, by choosing which and how much of
each output to produce and in what proportion to use the inputs—allocative effects (Jamison and Moock, 1984).

Singh, K. (2000) concludes with an overview finding that agricultural productivity is strongly determined by the level of technology adoption; and technology adoption is strongly determined by education of individuals and of the society.

2.2 (e) Farm Size and Agricultural Productivity:

Since last three decades farm size and agricultural productivity has become a great issue of debate for the economists of India. Some of the economists argue that there exists an inverse relationship between farm size and productivity while some economists argue that there is no existence of such relationship between farm size and agricultural productivity.

Sen, A.K. (1962) in his article entitled “An Aspect of Indian Agriculture” debated that an inverse relationship existed between the farm size and agricultural productivity in India. He argued that with the increase in size of holding, productivity declines and thus the productivity was more on small farms in comparison to large farms. He has offered three propositions in this regard (i) “When family labour employed in agriculture is given an ‘imputed value’ in terms of the ruling wage rate, much of the Indian agriculture seems unremunerative.” (ii) “By and large, the profitability of agriculture increases with the size of holding, ‘profitability being measured by the surplus’ (or deficit) of output over costs including the imputed value of labour.” (iii) “By and large, productivity per acre decreases with the size of holding.” Sen reached to this conclusion on the basis of the data made available by the Farm Management Surveys.
Having taken the Farm Management Survey data as A.K. Sen, many economists also reached to the same conclusion that indeed an inverse relationship existed between the farm size and agricultural productivity. Mazumder, Deepak (1965), too observed that “The data by Farm Management Surveys in India have added another example to a phenomenon observed in many parts of the underdeveloped world, viz, that in present agriculture, as the size of farms decrease the output per acre increases.”

Ghosh, A.K. (1979) re-examined the Farm Management Survey data and argues that an essential precondition for the existence of the inverse relationship phenomenon is technical backwardness.

Rudra and Sen (1980) attempted to review the main findings – both analytical as well as empirical- in the light of original presentation of issues. The general conclusion was the diversity of Indian agriculture with to the relationship between size and productivity: the negative relation may hold in certain parts of the country at certain times but not everywhere and not at every time. Even when the inverse relationship held, “it may hold in certain ranges but not in others, and in many cases it is particularly noticeable only for small size classes.” Rudra (1983) concluded that: “there is no scope propounding a general low (for an inverse relationship or even for a positive relationship).”

Barbier Pol (1984) has questioned the very logic of establishing the relationship between farm size and productivity. In his view, most research on the issue has been based on wrong assumptions and methodologies. He regarded the inverse relationship thesis as spurious and without any theoretical meaning.
To conclude on the above contradictory topic from the entire findings of the reviewed literature it can be stated that the difference in size of farms is one of the reasons for the variations in yields but, though in some studies, analysis of data shows an existence of inverse relationship between size of farm and yield, but the relation cannot be generalized.

2.3 Studies on Productivity Analysis:

Pandit, S. N. (1982) study on agricultural productivity in Uttar Pradesh addresses the broad objectives of examining the trends in area, output and yield of the main crops viz. rice, wheat, sugarcane etc. He analysed the behaviour of price and studied the supply response of rice, wheat and sugarcane and finally the work projected the future demand for food grains. His work entitled “Critical Study of Agricultural Productivity in Uttar Pradesh” 1951-1975 successfully furnishes the conclusion that agricultural development or an increase in productivity would lead to increase in the purchasing power of the rural poor and also helps increasing the growth of non-agricultural sector by providing a market for increase in production of industries. He has also verified empirically that trends in area of production and productivity has a direct bearing on agricultural development of the state. The study also finds that the productivity of rice, wheat, sugarcane, gram and maize increases both in area and production. But during the period under consideration, the area, production and productivity of barley and gram have declined. However the yield of all the selected crops maintained an overall positive rate of growth, Estimating the cropping pattern of the state the author observes that percentage share of rice in gross cropped area remained constant at around 19 percent while in the case of wheat its increase was considerable. He also finds that agricultural productivity cannot be increased through horizontal expansion of land. Increase in agricultural productivity is possible only through the vertical
expansion of land, by increasing area under irrigation, using chemical fertilizers and by increasing areas under HYV seeds. The study also reveals that in U.P. the general price level is mostly influenced by the behavior of agricultural prices. The degree of availability of prices of rice was however less according to his investigation. The study finally suggests the use of such farm technologically which keeps land permanently under cultivation and that be developed and used properly to increase agricultural productivity.

Sofi, M in his work “Agricultural productivity and Regional Imbalances” (1984) considers agricultural productivity or agricultural production as an important determinant in regional imbalances. He identifies the most important factors in locating the causes of regional imbalances and in diagnosing the process of increasing productivity or production. He studied the land use pattern, land holding size and its distribution, the inception of intensive cultivation programmes, the ground water resources, the problem of waste land and finally examines the area production, productivity of thirteen crops available in Uttar Pradesh, in four categories viz, cereals, pulses, oil seeds and cash crops. He also studied the cropping pattern of these crops in terms of rate of growth.

On the basis of the measurement of agricultural productivity he demarcated the productivity regions. He measured agricultural productivity by seven different methods and studied the differences arising out of the sensitivity of these methods. He then attempted to find out the best method for assessment of productivity and concluded that the method based on SNU (Standard Nutrition per unit output per hectare) is the best in measuring productivity.

He lastly fits the Cobb-Douglas types of function for input-output relationship in agriculture. This function depicts the relationship between inputs like irrigation by canals, by other sources,
and fertilizer inputs. This equation showed that 1% change in irrigation by canals results either in about 0.01653 percent change in low productivity regions or about 1082.14 SNUs whereas a change of 1 percent irrigation by other sources will bring change either of 0.022 percent in productivity or an additional production of 1458.36 NSUs. Again 1 percent change in the fertilizers anticipated a change of 0.1777 percent in the productivity index or an additional output of 11,618.15 SNUs. Further he estimated that 1 percent change in labour will bring a change of (-0.09967) per unit in the net value of the productivity or an increased production of about 65,257.95 SNUs. The study therefore concludes that a change of 1 percent irrigation by canals, 1 percent by other sources, fertilizer and 1 percent negative change in human labour bring an additional output of 79,415.95 SNUs which can afford to sustain an additional population of about 80 thousand persons in the low productivity regions of the state.

The study also reveals that 60 percent of urban and 70 percent of rural diet comes from rice, wheat, pulses and potatoes. He also made an assessment regarding future position and concludes that demand for food stuff in relation to supply and in relation to population was discouraging in respect of rice and pulses till the end of this century. His estimate reveals that in case of rice, the shortage will be about 0.5 million tone in 1985-86, 2.28 million tone in 1990-91, 3.3 million tone in 1995-96 and 4.2 million tones in 2000-2001 for the state as a whole.

The author then makes an attempt to suggest possible ways of reducing regional imbalance in regard to productivity. He suggested that in order to reduce imbalances in productivity, efforts should be made to raise the productivity of the low and medium areas at par with at least medium and high productivity regions.
Bhau,D.S(1990) in his work “Agricultural productivity in India” (impact of chemical fertilizers) considers the impact of chemical fertilizers on agricultural productivity. According to him, in spite of availability of labour and other inputs of agriculture, marginal productivity is very low and sometimes zero. He therefore attaches Indian agricultural development to the levels of technology used in the process of production. It is because of this that India doesn’t have sufficient opportunity to invest in modern inputs such as fertilizers, HYV seeds etc. The author considered only the impact of chemical fertilizers on agricultural production.

The author deserves that Indian farmers are ignorant about the optimum doses of fertilizers of a crop and for that matter they don’t use optimum doses in the production of crops. However very few farmers have such knowledge of optimum doses of fertilizers, yet they don’t use in optimum quantity. Many factors are responsible for these two cases. In the first factor responsible for less use of fertilizers are carelessness on the part of the farmers, inadequate and improper guidance by the concerned department, lack of co-ordination between farmers and the concerned department, illiteracy on the part of the farmers and so son. The factors responsible for second category, i.e. in spite of adequate knowledge why farmers do not use fertilizers, according to the author are lack of purchasing power on the part of the farmers, lack of credit facilities, higher cost of fertilizers and improper distribution of fertilizers etc.

The author observes that due to the lack of knowledge farmers do not apply fertilizers at proper time. A more doses knowingly or unknowingly applied by some at proper time, whereas the remaining doses were not at all applied. The medium and small farmers used only up to second doses, while medium and large farmers used up to last and third doses of fertilizers. The reason behind this according to the author are, lack of knowledge on the part of the farmers,
malpractices on the part of the co-operative dealer, irregular supply of fertilizers, lack of credit
fertilizers etc.

Finally the author makes attempt to study the relationship between fertilizer consumption and its
impact on various outputs and finds that in case of all varieties of wheat the relation is positive,
in case of oilseeds the relation may either be positive or negative. This clearly indicates that in
case of oilseeds fertilizer is the least significant factor. In case of paddy also it is difficult to
establish, whether the relation is positive or negative.

This is also due to fact that paddy output depends largely on other factors, rather than on
fertilizers. In case of moong and mash (pulses), however there is negative relation between
fertilizers consumption and output i.e. with the increase in fertilizers production decreases.

Lastly to increase consumption of fertilizers the author suggest, avoidance of artificial scarcity,
fair distribution, reasonable price level, soil testing etc.

The study no doubt is successful in achieving its objectives viz, to study the possible effect of
chemical fertilizers on output, yet not whole heartedly acceptable. India is a land with diverse
character of soil, irrigation facilities and such other factors which mainly govern agricultural
production. The author considers only the fertilizers. Therefore changes in production and
productivity may not be wholly dependent on the function of fertilizers.

Further there are infinite varieties of products produced in all over the India; the author considers
only the selected few. The reason put forward by the author for less use of fertilizers or improper
use of fertilizers etc. are no doubt true, yet along with these factors, there are some other factor
such as attitude of farmers and the like which author doesn’t foresee. Due to these reasons the study losses its significance.

Munir, A (1992) in his work considered the effects of agricultural productivity in development. Based on the data from district statistical bulletins and information from district statistical offices of a few districts of U.P., covering a total area of 26,356 sq.km., he identified areas of high and low agricultural productivity, at varying levels of development and examined, on the basis of that, the relationship between agricultural productivity and levels of development.

According to him agricultural productivity varies from place to place. The natural factors such as rainfall, soil etc. are less significant. The other factors such as pattern of cultivation, quality of seeds, fertilizers i.e. those which are non-environmental in nature contribute more to variation in agricultural productivity in different areas or regions. He finds that the regions or areas with high initial income or productivity are technologically more advanced and have a land use pattern which is conducive for further increase in agricultural productivity or income. He also finds that the regions having higher productivity have the initial advantage of agro-based industrialization, which also contributes in augmenting agricultural productivity. Further he has observed that agricultural productivity is not the unique factor leading variation in development among regions. Some other factor such as urbanization and modernization are among the things which cause developmental variation.

The relation between agricultural productivity and levels of development are found to be positive according to the study. This clearly indicates that agricultural productivity among other factors contributes to a great extent to the regional development.
Agricultural productivity provides the base for industrialization and urbanization of which the later strengthen industrial, commercial and business activities as he finds that all these factors developed in the areas of high agricultural productivity.

The study also reveals that low productivity and hence the resulting backwardness of the regions is mainly due to the lack of commercialization of agriculture. Opening up of new commercial centers is a remedy of low agricultural productivity according to the author. This will help to increase production of commercial crops and thereby help in the process of industrialization. The excess of output or income produced due to commercialization of agriculture if reinvested in agriculture in the form of modern inputs may increase agricultural productivity. Financial assistance to agriculturists is considered as equally important factor to increase agricultural productivity. Large scale unemployment of rural agricultural people increased the pressure of population on land and thereby declining labour productivity. Establishment of cottage and household industries in the rural areas is a solution to this problem according to the author. This will help in increasing productivity.

The study is interesting in so far as it attempts to focus on the factors of urbanization and modernization. However the views of the author are contradictory as he assumes that initial level of high income and already high productivity can trigger off higher agricultural production whereas he also maintains at a later stage that higher agricultural productivity leads to urbanization and modernization. As a result one fails to understand the cause and effect relationship of the variables under investigation due to which the study losses much of its significance.
In an important discussion on the changes that have taken place in the field of agriculture in North-East region of India, Mahapatra (2006) pointed out that the key to agricultural prosperity lies in the growth of yield. Except for the two states of Manipur and Tripura where the rice yield is around the national average, the average rice yield grew at a rate of 1.5 percent during the entire period of 1985-98, and was less than 0.5 percent during the nineties. These points towards stagnancy in agricultural production. The story of changes appeared dismal to the author.

Examining the development needs of North-East farmers, Chakrabarty D.N. (2006) observed that the productivity of rainfed rice in North-East region of India is constrained by the unfavourable biophysical and complex socio-economic conditions. The farmers in this region, particularly in the state of Assam, have to operate their rice cultivation practices under stressful situation such as unpredictable and erratic rainfall resulting in flood, water logging, drought, nutrient deficiencies and toxicities, weds, insect pests and diseases pressures. This led to marning situation of heterogeneous and variable nature. This situation emphasise the need for relevant technologies as per climate variation, soil characteristics and position in the landscape, depth of water and other variables. The article stresses the point that the technologies developed are not perfected as per agro-ecological condition, economic conditions and the perfection and aspiration of the farmers.

Hirano Y. Ochi S. and Shibasaki R (1998) of Tokyo University has studied on “Estimation of Agricultural Productivity Distribution in India”. They have realized that improvement in agricultural productivity has become a necessity due to the limitation in expansion of cultivated acreage and ever increasing food demand. To forecast the growth of agricultural productivity, crop production data aggregated by administrative zone such as states and nations along are not
sufficient because it is necessary to take into account environmental and land conditions specific
to each location. With this background, this paper discusses a method to estimate the distribution
of agricultural productivity as case study of India. The distribution of NPP for each grid cell
(8km resolution) was estimated using the NDVI data derived from NOAA AVHRR and PAR.
NPP in crop land was extracted using the land use data and has been summed up by each
districts. Correlation of the agricultural productivity and NPP were investigated by comparing
statistical crop production data on each district.

Considering the external reality of the North-East region, Chakraborty, G (2002) observes that
along with scientific measures, an improvement in the skill and outlook of the man behind the
plough is very important in the process of increasing productivity in the agricultural sectors.

Revealing the low input utilization level in different states of India, Gulati, R.K. (1999) pointed
out that irrigation intensity in Assam is extremely low at 15.06 in 1990-91 as compared to 94.04
in Panjab. Number of electric pump-sets for thousand hectare of cultivated area is only 1.74 in
Assam in 1990-91 whereas the corresponding figure is 161.31, the highest, in Tamilnadu. In case
of fertilizer, Assam consumes only 10.5 kg per hectre of gross cropped area in 1990-91, the
corresponding figure is 171.20 kg per hectre in Punjab. The figures representing area under HYV
as percentage of cropped area are 28.65 and 71.67 for Assam and Punjab respectively in 1990-
91.

In the context of HYV seed-fertilizer technology, Bezbaruah, M.P. (1994) observes that in
Assam, there are evidence of farmers by and large adopting HYV seeds but the application of
supporting inputs like fertilizers has remained at a low level and the agricultural growth there has
been found to be constrained by lack of development of irrigation infrastructure.
Discussing emerging micro-trends in agricultural sector of Assam, Chakrabarty, G (2006) pointed out that from the latter half of the 90's a new variety of paddy known as iri has been introduced in the char areas of Assam. As the yield is higher, the availability of food grains has, therefore increased for those who undertake iri cultivation. This has reduced their economic vulnerability to a great extent.

In another study on the char areas of Assam, Jasmin, N (2006) observed that large number of people had migrated from the char area due to different reasons such as inadequate job opportunities in char areas, less of land and property in erosion etc. out of those migrated from a particular area, 44 percent were marginal farmers, 35.5 percent were agricultural labour, 7.5 percent were seasonal agricultural workers, and 5.5 percent were attached or bonded labourers.

Dutta, S. and Akond, M.I., (2010) in their study addresses the basic area of the problem of agricultural development by delving on the issue of the estimation of rice productivity and identification of its proximate determinants in the char areas of Assam. Data is collected from the char areas of Dhubri district with the help of a structured questionnaire from 210 agricultural farm households of all parts of the district. Simple regression analysis is used for identification of the determinants of rice productivity. The results of the study reveal that irrigation, chemical fertilizer, Labour man days, experience of farming and education level of the main farmers have significant positive impact on rice productivity whereas Manure used for rice cultivation has significant negative impact. Although rice productivity in char areas is found to be higher than the state average, the study indicates the existence of high level of zonal disparity in rice productivity in the study area.
2.4 Studies on Technical Efficiency Analysis:

Farrell, M. J. (1957) carried out the first empirical study to measure Technical Efficiency (TE) for a cross-section of production units by using deterministic / no parametric frontier approach and, consequently, frontier efficiency comparisons have become synonymous with the term “Farrell efficiency measurement”. This measure assumes that the production function of fully efficient unit is known in some manner. Since the actual production function is never known in practice, Farrell suggests that it can be estimated from the sample data using either a non-parametric function such as one of Cobb-Douglas form.

Aigner and Chu (1968) a deterministic parametric frontier using a homogenous Cobb-Douglas production function. Later Timmer (1971) converted the deterministic frontier into a probabilistic frontier method. However the approach has some limitations. All farms share a common frontier and any variations in farm efficiency are measured relative to this frontier. This approach ignores any random factors that can influence the efficiency of a farm (such as climate). Moreover, the results of this approach are highly sensitive to variable selection and data errors.

Aigner et al. (1977) and Meeusen and Broeck (1977), independently developed a stochastic frontier approach to measure TE. This approach introduces TE as a multiplicative (neutral) shift variable within a production function framework. This means that the input coefficients of the conventional production function and that of the frontier function are the same and only the intercept term changes. In practice, with cross-section data, the distribution of the TE term must be specified as half-normal, truncated normal, or otherwise. As suggested independently by Jondrow et al (1982) and Kalirajan and Flinn (1983), one can calculate individual specific TE
values by using this procedure. This particular approach has been extended in various ways, such as the specification of more general distributions for the residual term (experimental and gamma), the consideration of panel data for analysis, and the measurement of TE using cost / profit functions. A number of comprehensive literature reviews are available, such as Forsund et al. (1980), Bauer (1990), Battese (1992), Greene (1993) and Kalirajan and Shand (1994).

A few empirical studies provide the estimates of TE of raising a particular crop (mostly rice) within a state/region. For instance, Kalirajan (1981), Shanmugam and Palanisamy (1993), Tadesse and Krishnamoorthy (1997) and Mythili and Shanmugam (2000), estimated the TE of rice farms in Tamil Nadu. Dutta and Joshi (1992) measured the TE of rice farms in Uttar Pradesh while Shanmugam (2002) measured the TE of raising rice crop in Karnataka respectively. Shanmugam (2000) estimated the efficiency of rice farms in Bihar. An exception is Shanmugam (2003), which provides TE of rice, cotton and groundnut growing farms in Tamil Nadu. The results of these studies are useful for policy makers to rationalize the development policies for a particular crop in region. Kalirajan, K.P et al (1996) studied the productivity growth of Chinese agriculture before and after reforms with an objective to explain a method to decompose the sources of total factor productivity growth into technical progress and changes in technical efficiency within the framework of the varying coefficients frontier production function. An empirical application is demonstrated using the Chinese provincial level agricultural data covering the period 1970-87. The results indicate that TFP growth in the pre reform period was negative in twenty out of twenty-eight provinces and that it is positive in almost all provinces during the reform period, while negative in sixteen out of twenty eight provinces in the post reform periods of 1984-87.
The paper by Broeck et al., (1980) basically compares two estimates of efficiencies using deterministic and stochastic frontier production function. The estimates are carried out on a cross-section of data of 28 Swedish diary farms for the period 1964-1973. Results for the poled data set are also given and a number of structural efficiency measures are computed. Estimation of deterministic frontier production function models begin with a production function of general homothetic form:

\[
G(x) = g(v)u, \quad u \in (0, 1)
\]

Where, \(x\) is the rate of outputs, \(G(.)\) a monotonic increasing function, \(g(.)\) a homogenous function of degree 1. The appearance of \(u\) on the right-hand side implies focus on the measurement of the input efficiency. The computation of the function is based on minimizing the simple sum of deviation from frontier.

For the stochastic frontier function model, \(u\) is assumed to have two parts: one is pure random part and other is efficiency part. The parameters of the models are estimated by three methods, LP method, MLE method and Composed error term (ML-CE). They found a systematic pattern of differences among the values of parameters and concluded that the estimates of structural efficiency corresponding to the LP and ML estimations are significantly lower than ML-CE values. The choice between deterministic and stochastic frontiers must be made on the information about the quality of data and on the purpose of study.

Page, John M. (Jr) (1984) in his study, "Farm Size and Technical Efficiency: Application of production Frontiers to Indian Survey Data" has measured technical efficiency of manufacturing firms in India for the year 1979-80 using the deterministic approach of production frontier. The
paper investigates the relationship between technical efficiency and firm size in the Indian manufacturing industry. The sources of variation of technical efficiency are investigated and the firm size is found to be positively associated with relative productive efficiency.

Kalirajan, (1986) in his work measuring, “Technical Efficiencies from Interdependent Multiple Output Frontiers,” measures technical efficiencies of 73 randomly selected farmers from the province of Laguna in the Philippines. The novelty of the paper is that the firm-specific, output specific technical efficiencies are measured by estimating a system of production frontiers representing multiple outputs and the model explains the sequence of production, i.e. consecutive output depends not only on the input set but also on the previous set of output. The firm-specific output-specific technical efficiencies are calculated from the MLE of the frontier production function. The empirical results of the study indicate that there is need to improve technical efficiency of majority of farmers even in the advanced agricultural areas.

Kumbhakar, S. C. (1988) in his study, “On the Estimation of Technical Efficiency and Allocative Efficiency Using Stochastic Frontier Function: The Case of US Class-I Railroads,” proposes a flexible functional form of the production technology that permits elasticities of output to vary across firms and to introduce allocative efficiency separate from random errors in optimization. Maximum Likelihood Estimation is developed in a panel data framework. This model is applied to a panel data of 42 US Class-I railroads for the period 1951-75. A generalized production function is taken to estimate the elasticities of output and the efficiencies. To allow the possibility of structural change in the regularity environment the sample period is divided into five sub-periods. The paper concludes that the elasticities vary substantially between railroads and the Cobb-Douglas specification is rejected for all the sub-periods except the last. The mean cost of
technical inefficiency over sub-periods does not show any specific pattern. Wide variations in allocative inefficiencies are observed along the railroads. Though these inefficiencies are not due to over-capitalization, the industry as a whole shows over-capitalization in successive sub-periods. Finally, the results show that for some of the railroads cost of allocative inefficiencies is greater than that of technical inefficiencies and the roads having lower cost for TE do not have lower cost due to allocative inefficiency.

Battese, G. E., Coelli, T. J. (1988), has studied on, “Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data.” In this study a stochastic frontier production function is defined for panel data on sample firms, such that the disturbances associated with observations for a given firm involve the differences between traditional symmetric random errors and a non-negative random variable, which is associated with the technical efficiency of the firm. Given that the non-negative firm effects are time-invariant and have a general truncated normal distribution, we obtain the best predictor for the firm-effect random variable and the appropriate technical efficiency of an individual firm, given the values of the disturbances in the model. The results obtained are a generalization of those presented by Jondrow et al. (1982) for a cross-sectional model in which the firm effects have half-normal distribution. The model is applied in the analysis of three years of data for dairy farms in Australia.

Ferrier, G.D. and C.A.K. Lovell (1990), in their work “Measuring Cost Efficiency in Banking: Econometric and Linear Programming Evidence,” measure cost efficiency in the banking sector in the US and also compare the ability of econometric and linear programming technique. The data used for this study was taken from 575 banks which participated in the Federal Reserve
Systems Financial Cost Analysis Programme in the year 1984, which is stated to be a rich source of US banking sector. Econometrics approach involves the estimation of cost function while linear programming calculates a production frontier. The results of Translog Cost Frontier suggest that (i) an efficient frontier exhibiting small but pervasive scale economies and (ii) banks operating a observed coast regularly 26 percent higher than frontier cost, due to primarily to excessive labor utilization. The results of non-stochastic production frontier suggest that technical inefficiency is rather high and most efficient banks belong to the small size class. Since the techniques are different there is a difference in magnitude of calculated cost of both technical and allocative inefficiencies. However the ranking of bank according to technical efficiency derived from the two methods is positive but not statistically significant.

Cornwell, C., Schmidt, P. and Sickles, R.C. (1990) in their study 'Production Frontier with Cross-sectional and Time series Variation in Efficiency Levels,' estimate a time varying efficiency using panel data model. In this paper, they introduce a production frontier of time with coefficients varying over firms. It implies that the level of efficiency for each firm vary over time. This model is similar to that of Sickles, Good, and Johnsen (1986) but the present paper allows cross-sectional variation in productivity growth rates. The paper uses a panel data of 48 time points. The data is outputs and inputs figures and price over 2.50 accounts from the CAB Form-41 for the year 1970-I to 1980-IV. Efficiencies are calculated using within estimate, instrumental variable, and GLS method. It is found that efficiencies calculated from within estimates and instrumental variable estimates are similar while that of GLS are quite different. However, in either case there is a considerable variation of the ranking of the efficiencies over time. Average efficiencies for the years indicate a rising trend in efficiency and this increase occurred even before the formal process of deregulation in late 1978.
Kumbhakar, S.C (1990) used a panel data framework and models of farm-specific technical efficiency allowing to vary over time. The specification used is quite flexible. It can accommodate increasing, decreasing and time-invariant behavior of technical. And based on the assumption of cost minimization, time varying farm and input specific allocative inefficiency was also incorporated. The ML estimation method, based on a parametric production function, was developed to estimate the parameters. Estimates of technical and allocative inefficiency based on the ML parameter estimates were also suggested. Finally, formulae for calculating costs of technical and allocative inefficiency were derived.

Kumbhakar, S.C et al (1991), in their study on the technical efficiency and technical progress in Swedish dairy farms, attempted to develop a method of separating technical inefficiency from individual specific efforts. They presented a two step method that separates technical inefficiency from individual-specific efforts. The first step provided consistent estimates of the production function parameters which were used in the second step, to estimate individual-specific effects, parameters of the error components and technical efficiency for each unit over time. In the empirical implementation this two-step procedure was used to examine technical efficiency and technical progress for two panel data sets of Swedish Dairy farms covering periods 1960-1967 and 1968-1976. The first set had 29 and the second set had 67 farms. The underlying technology was assumed translog but in the first period a CD technology could not be rejected. The parameter results in both models were of the correct sign, reasonable and with small standard errors. The efficiency distribution of farms exhibited remarkable similarity during 1960-1967 and 1968-1975 except in the lowest and highest groups. The efficiency level of farms in the highest and lowest efficiency groups was found improved substantially between the periods.
Kalirajan, K.P etal (1999), reviewed the various methodologies for measuring technical efficiency and offered a comparison between established methods of measurements. Their discussion is literary and less mathematical jargons and equations. The objective of their paper is not to be exhaustive but to be up to date and to provide a significant discussion on some of the core methods of measuring technical efficiency. The different methods of measuring technical efficiency included in their study are- the deterministic frontier production function, the stochastic frontier production function approach (SFA), the stochastic varying coefficients frontier approach (SVFA) and Bayesian approach.

Bravo-Urata B. E. and Pinheiro A. E. (1993) of Connecticut University has published an article “Efficiency Analysis of Developing Country Agriculture: A Review of the Frontier Function Literature”. This article reviews and critiques the frontier literature dealing with farm level efficiency in developing countries. A total of 30 studies from 14 different countries are examined. The country that has received most attention is India, while rice has been the most studied agricultural product. The average technical efficiency (TE) index from all the studies reviewed is 7270. The few studies reporting allocative and economic efficiency show an average of 68% and 43%, respectively. These results suggest that there is considerable room to increase agricultural output without additional inputs and given existing technology.

Bravo-Ureta, B. E., Evenson, R. E. (1993), have studied on, “Efficiency in agricultural production: The case of peasant farmers in eastern Paraguay” This paper contributes to the productivity literature in developing country agriculture by quantifying the level of efficiency for a sample of peasant farmers from Eastern Paraguay. A stochastic efficiency decomposition methodology is used to derive technical, allocative and economic efficiency measures separately.
for cotton and cassava. An average economic efficiency of 40.1% for cotton and of 52.\texttimes for cassava is found, which suggests considerable room for productivity gains for the farms in the sample through better use of available resources given the state of technology. Gains in output through productivity growth have become increasingly important to Paraguay as the opportunities to bring additional virgin lands into cultivation have significantly diminished in recent years. No clear strategy to improve farm productivity could be gleaned from an examination of the relationship between efficiency and various socioeconomic variables. One possible explanation for this finding is the existence of a stage of development threshold below which there is no consistent relationship between socioeconomic variables and productivity. If this is the case, then our results suggest that this sample of Paraguayan peasants is yet to reach such a threshold. Hence, improvements in educational and extension services, for example, would be needed to go beyond this threshold. Once this is accomplished, additional productivity gains would be obtained by further investments in human capital and related factors.

Son, T. Vo. H. et al. (1993), have studied on, “Analysis of the technical efficiency of state rubber farms in Vietnam” This study entails an analysis of the technical efficiency of natural rubber production by state farms in Vietnam. A time-varying stochastic frontier production function model for unbalanced data is estimated for 33 farms. Individual farm technical efficiencies are reported and discussed. One of the main results concerns the bimodal distribution of technical efficiency indices. A few farms operate near the production frontier while the bulk operate well away from the frontier. Some implications are drawn from the results as a guide to future policy research work in the rubber industry in light of recent moves by the Vietnamese government towards economic reform.
In a paper, 'Inter-temporal Efficiency Variations in Indian manufacturing industries,' Neogi, C. and Ghosh, B. (1994) has estimated technical efficiencies of Indian manufacturing industries by both fixed ranking and time varying approach. The study applies the models developed by Battes and Coelli (1992) and Cornwell et al (1990). It has been found that the data on manufacturing industries in India (Annual Survey of Industries) for the period 1977-75 to 1987-88 follows the time varying model. The Technical Efficiencies of industries show a downward trend over the study period. Estimates of time-varying efficiencies of manufacturing industries indicate that out of 35 industries efficiencies of 25 have been falling substantially over time and most of them are from traditional industries. Secondly, most of the industries in the modern sector have shown upward trend of technical efficiencies. Ranking of industries in terms of technical efficiencies, there is a swap between modern and traditional industries in favor of modern industries. Finally factors like labour productivity, skill profit, and capital utilization positively affect efficiency of industries.

A three-stage estimation of a panel data has been used by Kumbhakar and Hjalmarsson (1995) to find out the parameters of a translog function of input requirement. After obtaining the estimates they consider the estimate of $U$ to calculate the labour-use technical efficiency of firms. In this paper they formulate a model to estimate labour-use efficiency for the Swedish local insurance office for the period 1974-1984. The major findings of the papers are: (a) there are increasing returns to scale in every year, (b) there is evidence of slight decrease in labour productivity over time, and (c) the mean labour-use efficiency is found varying between 77.42 to 82.85 per cent.

Heshmati, A. et al. (1995), has studied on, "Efficiency of the Swedish pork industry: A farm level study using rotating panel data 1976-1988." This paper investigates the issues of technical
efficiency, technical changes and bias in technical change in the Swedish pork industry using rotating panel data. We use a generalized Cobb-Douglas model, where the coefficients are linear functions of time. This allows input elasticities to vary over time. Technical changes and bias in technical change are farm-and time-specific. The model distinguishes farm heterogeneity from technical inefficiency. We use a corrected least squares procedure to estimate the model. The data consists of a rotating panel of 450 pork producing farms with a total number of 1506 observations during the period of 1976–1988. We compare the productive performance of farms by size of farm land and animal stock, and over time. The empirical results show among other things that technical change is found to be positive but rapidly declining during the period 1976–1980 turning into technical regress during the remaining period, 1981 to 1988. The mean technical efficiency is found to be around 91%.

Kurkalova L. A. and Jensen H. H. (1996) of Center for Agricultural and Rural Development (CARD) at Iowa State University has studied on A representative sample of 49 state and collective farms in Ukraine provides data in physical units on livestock and crop production and input use for 1989-92. The changes in production efficiency for beef, pork, dairy, winter wheat, grain, and potato production, investigated using stochastic frontier methods, show declining technical efficiency in livestock production and especially low marginal contribution of labor inputs. The number of workers, size of farm, and distance from nearest city are related to efficiency in agricultural production.

Apezteguia, B. I., Garate, M. R. (1997), have studied on, “Technical efficiency in the Spanish agrofood industry” This study estimates frontier production functions with cross-section data for the Spanish agrofood industry by using deterministic and stochastic parametric approaches. We
compute the individual technical efficiency for each firm, compare the results and explain the relationship between technical efficiency and other relevant quantitative variables. The results indicate that the Spanish agro food industry has a level of efficiency between 68% and 93%; which means that it is potentially capable of increasing production without increasing its consumption of inputs. This efficiency level is positively related to factor productivity and unitary labour costs.

Tadesse, B., Krishnamoorthy, S. (1997), in their study, “Technical efficiency in paddy farms of Tamil Nadu: An analysis based on farm size and ecological zone”, despite the wider application of efficiency analysis in Indian agriculture, little has been done on the investigation of intra and inter ecological variations, size differences and their interactions. However, ecological issues have paramount implications for the low-input sustainable agricultural production. Furthermore, due to the various causes of efficiency, the age-old size-based debate on efficiency differences is not yet resolved. The present study examines the level of technical efficiency across ecological zones and farm size groups in paddy farms of the southern Indian state of Tamil Nadu. The study showed that 90% of the variation in output among paddy (IR-20) farms in the state is due to differences in technical efficiency. Land, animal power and fertilisers have significant influence on the level of paddy production. Varying from 0.59 to 0.97, the mean technical efficiency was found to be 0.83. The use of F-test in two-way analysis of variance (ANOVA) and censored regression (Tobit model), with dummies for ecological zones, farm size groups and their interactions, has shown that, at mean level, the level of technical efficiency among paddy farms of the state differs significantly across agro-ecological zones and size groups as well. The study further indicated that small-sized paddy farms in zone II and medium-sized paddy farms in zone
III are represented by ecologically size-biased production techniques; thus achieving higher technical efficiency.

Sharma, K. R. et al. (1997), in their study, "Technical, allocative and economic efficiencies in swine production in Hawaii: a comparison of parametric and nonparametric approaches" technical, allocative and economic efficiency measures are derived for a sample of swine producers in Hawaii using the parametric stochastic efficiency decomposition technique and nonparametric data envelopment analysis (DEA). Efficiency measures obtained from the two frontier approaches are compared. Firm-specific factors affecting productive efficiencies are also analyzed. Finally, swine producers' potential for reducing cost through improved efficiency is also examined. Under the specification of variable returns to scale (VRS), the mean technical, allocative and economic efficiency indices are 75.9 percent, 75.8 percent and 57.1 percent, respectively, for the parametric approach and 75.9 percent, 80.3 percent and 60.3 percent for DEA; while for the constant returns to scale (CRS) they are 74.5 percent, 73.9 percent and 54.7 percent, respectively, for the parametric approach and 64.3 percent, 71.4 percent and 45.7 percent for DEA. Thus the results from both approaches reveal considerable inefficiencies in swine production in Hawaii. The removal of potential outliers increases the technical efficiencies in the parametric approach and allocative efficiencies in DEA, but, overall, contrary to popular belief, the results obtained from DEA are found to be more robust than those from the parametric approach. The estimated mean technical and economic efficiencies obtained from the parametric technique are higher than those from DEA for CRS models but quite similar for VRS models, while allocative efficiencies are generally higher in DEA. However, the efficiency rankings of the sample producers based on the two approaches are highly correlated, with the highest correlation being achieved for the technical efficiency rankings under CRS. Based on mean
comparison and rank correlation analyses, the return to scale assumption is found to be crucial in assessing the similarities or differences in efficiency measures obtained from the two approaches. Analysis of the role of various firm-specific factors on productive efficiency shows that farm size has strong positive effects on efficiency levels. Similarly, farms producing market hogs are more efficient than those producing feeder pigs. Based on these results, by operating at the efficient frontier the sample swine producers would be able to reduce their production costs by 38–46% depending upon the method and returns to scale considered.

Wilson, P. et al. (1999), have studied on, “The influence of management characteristics on the technical efficiency of wheat farmers in eastern England” In this study technical efficiency of wheat farms in eastern England is measured through the estimation of a stochastic frontier production function using panel data for the 1993–1997 crop years. Variations in the technical efficiency index across production units are explained through a number of managerial and farm characteristic variables following Battese and Coelli (1995) [Empirical Econ. 20, 325-332]. The technical efficiency index across production units ranges from 62 to 98 percent. The objectives of maximizing annual profits and maintaining the environment are positively correlated with, and have the largest influence on, technical efficiency. Moreover, those farmers who seek information, have more years of managerial experience, and have a large farm are also associated with higher levels of technical efficiency. Future studies that seek to explain variation in technical efficiency should include further aspects of the managerial decision-making process.

Shafiq, M., Rehman, T. (1999), have studied on, “The extent of resource use inefficiencies in cotton production in Pakistan’s Punjab: an application of Data Envelopment Analysis” This paper attempts to identify sources of resource use inefficiency for cotton production in Pakistan’s
Punjab. The use of a non-parametric method, Data Envelopment Analysis (DEA), is developed to study the relative technical and allocative efficiencies of individual farms which use similar inputs, produce the same product and operate under comparable circumstances. In the ‘cotton-wheat’ system of Pakistan, there are a considerable number of farms that are both technically and allocatively inefficient. The use of DEA shows that the technique provides a clear identification of both the extent and the sources of technical and allocative inefficiencies in cotton production. However, both the interpretation of the farm level results generated and the projection of these results to a higher level require care, given the technical nature of the agricultural production processes.

Fan, S. (1999) in his study, “Technical Change, Technical and Allocative Efficiency in Chinese Agriculture: The Case of Rice Production in Jiangsu,” he has developed a frontier shadow cost function approach to estimate empirically the effects of technological change, technical and allocative efficiency improvement in Chinese agriculture during the reform period (1980-93). The results reveal that the first phase rural reforms (1979-84) which focused on the decentralization of the production system have had significant impact on technical efficiency but not allocative efficiency. During the second phase reforms which was supposed to focus on the liberalization of rural markets, technical efficiency improved very little and allocative efficiency has increased only slightly, however. In contrast, the rate of technological change continued to increase, although at a declining rate during the second phase reform.

Krasachal, W. (2000) has studied on the topic, “Measurement of technical efficiency in Thai agricultural production.” The primary purpose of this study is to measure technical efficiency in Thai agricultural production during the period 1972 to 1994. The empirical application in this
study considers aggregate data from each of the four regions of Thailand for the period 1972-94. Inputs are classified into six groups: fertilizer, hired labour, capital, operator labour, unpaid family labour and land. The data for quantities of labour are based on annual statistical office (1997). This study decomposes technical efficiency into its pure technical and scale components. The data envelopment analysis (DEA) approach and annual data from 1972 to 1994 for four regions in Thailand are used. The empirical results suggest that there are significant possibilities to increase efficiency levels by increasing farm size. In addition, the availabilities of new land and the diversity of climate, natural resources, etc., could have had an influence on technical efficiency in Thai agricultural production.

Revilla-Molinai, I. M. et. al, (2001) in their study, “Improvement of technical efficiency in rice farming through interplanting: a stochastic frontier analysis in Yunnan, China,” gathered survey data from a random sample of 200 farmer adopters and 59 nonadopters of rice interplanting in Yunnan Province, China in 2000. The data for this study were obtained from a survey in Shiping, Jianshui, Mile Kaiyuan and Yuxi counties of Yunnan Province, conducted in July and October 2000. Ten households each from 20 adopter villages and 6 nonadopter villages were randomly selected and the head of the household was personally interviewed, using a semi-structured questionnaire. Adopter villages refer to villages where rice interplanting experiments within farmers’ fields had been conducted and farmers had been trained by extension workers. Nonadopter villages were located in areas with much less exposure to extension workers. For the final analysis, one nonadopter was dropped from the sample due to incomplete data. Information on farm household socio-economic characteristics, output and input use was collected during the survey. The data were used to analyze the effect of interplanting on technical efficiency of rice production and to identify the sources of inefficiency, using a stochastic frontier production
function. This study employs a stochastic frontier production function to measure the technical efficiency of rice production in Yunnan, China. Results showed that adoption of rice interplanting was the major contributing factor to increased technical efficiency in rice production. Separate analyses for adopters and nonadopters clearly showed that although rice interplanting was mainly aimed at controlling blast disease, the absence of the disease also increased the productivity of other inputs like labour, seeds and fertilizer. Farming experience and access to extension were both significant variables for improving technical efficiency. As a farmer’s experience increases, so do his skills in optimally allocating the resources at his/her disposal. The more experience a farmer has, the higher his output and the higher the technical efficiency. Similarly, farmers who had access to extension agents readily adopted the interplanting technology and as a result performed better.

Ahmed M. (2003) has studied “Agricultural Productivity, Efficiency, and Rural Poverty in Irrigated Pakistan: A Stochastic Production Frontier Analysis”. The main objective of this study is to estimate the input elasticities of production for poor and non-poor farms. The study estimates the stochastic frontier production function. The results show that the elasticities of production differ for poor and non-poor farms. The production elasticity of land is substantially higher on rich farms as compared to the farms belonging to poor farmers. This implies higher returns on investment on land by the rich farmers. The salinity/sodicity problem and the tail-end location of the plot adversely affect farm productivity and efficiency, particularly at the poor farms. Moreover, the average cost of the existence of technical inefficiencies is about 43 percent in terms of loss in output, with wide variations across farms ranging from 17 percent to 62 percent. The study further concludes that the least efficient group is not only operating far below the frontier but it also operates at the lower portion of the production frontier. Consequently,
increasing access to the inputs would likely raise productivity and reduce poverty. The results imply that the land distribution using the notion of land reforms in favour of poor/small farmers in the presence of existing farm structure, rural infrastructure, and the weak farm-supporting institutions is not expected to raise farm productivity and reduce poverty among the poor farmers. The results call for a strong and active role of the government in close partnership with the private sector to initiate income-generating activities and inputs supply chains in the rural areas to break the nexus of poverty, land degradation, and low agricultural productivity.

Nkamleu, Blaise, E. (2004), have studied on, “Productivity Growth, Technical Progress and Efficiency Change in African Agriculture.” The paper 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 present 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. Contrariwise, 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.
Johansson, Helena (2005), have studied on, “Technical, Allocative, and Economic Efficiency in Swedish Dairy Farms: The Data Envelopment Analysis Versus the Stochastic Frontier Approach.” In this study technical, allocative, and economic input efficiency scores were estimated for an unbalanced panel of Swedish dairy farms, using data envelopment analysis (DEA) and the stochastic frontier approach (SFA). By comparing the results it was concluded that when the entire dairy farm is studied the DEA is more appropriate to use since it does not require any particular parametric form to be chosen. The average DEA technical, allocative and economic efficiency indices were eventually found to be 0.77, 0.57, and 0.43 respectively. The influence of size on the efficiency scores was analyzed and significant evidence indicating a positive relationship between size and efficiency was found. Finally it was concluded that the main challenge facing the Swedish dairy farms is to enhance their cost minimizing skills.

Fuwa N.Edmonds C. and Banic P. has studied, (2005) “How inefficient are small-scale rice farmers in eastern India really? Examining the effects of microtopography on technical efficiency estimates”They focus on the impact of failing to control for differences in land types defined along toposequence on estimates of farm technical efficiency for small-scale rice farms in eastern India. In contrast with the existing literature, we find that those farms may be considerably more technically efficient than they appear from more aggregated analysis without such control. Farms planted with modern rice varieties are technically efficient. Furthermore, farms planted with traditional rice varieties operate close to the production frontier on less productive lands (upland and mid-upland), but significant technical inefficiency exists on more productive lands (medium land and lowland).
Kurkalova L. A. and Jensen H. H. (2005), of CARD has studied “Technical Efficiency of Grain Production in Ukraine”. In their study by using a representative sample of Ukrainian state and collective grain-producing farms, the authors estimate a stochastic production frontier model with technical inefficiency effects. Technical efficiency declined from 1989 to 1992. More experienced managers were found to be more productive, with the effect of experience diminishing with age. The authors find that on-farm provision of production infrastructure is associated with higher efficiency, a result supporting the hypothesis that disorganization causes output to decline in transition economies.

Thiam A, Bravo-Ureta B. E. and Rivas T. E. (2005) of Connecticut University has published an article, “Technical efficiency in developing country agriculture: a meta-analysis”. In their study a meta-analysis is performed to review empirical estimates of technical efficiency (TE) in developing country agriculture. The objective of the study is to contribute to a better understanding of the factors that influence estimates of mean TE. A data set of 51 observations of TE from 32 studies is used in order to test if specific characteristics of the data and econometric specifications account for systematic differences in the efficiency estimates. Results using the two-limit Tobit procedure indicate that factors such as primal versus dual, number of fixed inputs and number of variable inputs increase average TE estimates. On the other hand, using the Cobb-Douglas functional form and cross-sectional data yields a lower level of TE. Other factors, including the number of variables in the model, crop type, stochastic versus deterministic frontiers and sample size, do not seem to significantly affect estimates of TE across studies.
Arsalanbod, M. (2005) in his study, ‘The Efficiency of Farmers in North-West of Iran’ has estimated the efficiency measures of individual sample farmers. The data used in this study based on the results of a survey of agricultural production in the North-West of Iran in the West Azarbayjan Province, bordering Iraq and Turkey. The survey is on annual crops for the year 2001. In a two stage sampling, first a random sample of villages were chosen and in the second stage, a random sample of farmers in each sample village were chosen. By interviewing the sample farmers and filling out the questionnaire the necessary data were collected. Altogether the data on 1,521 enterprises of annual crops were used in this study. The data on six variables were used to estimate the production function specified. The variables are: monetary value of output in toomans, land in hectares, and costs of seeds, fertilizer, machinery, and labour in toomans. One tooman is equivalent to ten rials.

Using FRONTIER version 4.1 software by Coelli (1996), the efficiency measures of individual sample farmers and their mean were estimated. Mean efficiency was estimated to be 93.04 percent; 0.39 percent of farmers had efficiencies of less than 80 percent, 7.89 percent of them had efficiencies between 80 and 90 percent, and 91.72 percent of the farmers had efficiencies more than 90 percent. The results of this study indicate that there is some potential to increase production through enhancing the efficiency of agricultural producers.

Kumar, S. and Sandeep kumar (2005) in their work ‘Resource Use Efficiency and Returns from Selected Food grain Crops of Himachal Pradesh: A Study of Low Hill Zone,’ present a study of the resource use efficiency of key factors of production returns to scale and profitability of the selected food grain crops in Himachal Pradesh. In this study low-hill zone has been purposively selected for the empirical investigation on account of similar agro-climatic conditions, cropping
patterns, having good production potential, fertile soil, good road and communication network etc. Again two blocks viz. Una and Ghumarwin have been selected randomly and purposively from the respective two districts, namely Ua and Bilaspur. After that three panchayats from each block and three villages from each panchayat have been selected with the help of multi-stage random sampling. In addition to this, the selected categories of farms have further been divided into three size-class viz., marginal farmers having land less than 1 hectare, small farmers having land 1-2 hectors and medium farmers having land more than 2 hectors. The data pertaining to the year 2001-2002 were collected by survey method with the help of a well structured schedule from 200 farms consisting of 98 marginal, 62 small and 40 medium farms selected randomly on the basis of probability proportional to the number of farms in each size class. In order to examine the cost and net returns, the simple tabular analysis consisting of averages, percentages etc. was extensively employed. Again, to judge the resource use efficiency, returns to scale and to indicate improvement in input utilization, the unrestricted form of Cobb-Douglas production function was fitted to the cross-section data and the choice of explanatory variables was restricted only to six.

In this study the results of resource use efficiency and returns to scale indicated that there exists a vast scope to increase food grain production and to turn out negative returns into positive by overcoming the inefficient use of different inputs used in the cultivation of different crops viz., maize, paddy, and wheat. The overall analysis of these crops suggested that the farmers should use more of high yielding variety seeds (HYVs) in place of homegrown seeds, insecticides and pesticides, bullock labour and tractorization, improved implements etc. in order to increase the agricultural production. The farmers of the study area should curtail expenditure on the farm buildings, depreciation and repair, traditional equipments, homegrown seeds etc., in order to
avoid losses as the expenditure on these items is as high as compared to their contribution to crop output. The farmers are in general, quite efficient in the use of their resources particularly in land, human labour and manure and fertilizers.

Rajendran, K. and Mohanty, S. (2005), has studied on, “Efficiency of Milk production in India: A Stochastic Frontier Production Function Approach” In their paper they estimate the technical efficiency of Indian dairy farms using stochastic frontier production functions using primary data. They purposively selected dharampuri district of Tamilnadu (a southern Indian state) and collected primary data for the period of January-March 1999. A multi-stage random sampling technique is adopted to selecting sample households. A random sample of 111 farmers is chosen from the 293 farmers within the two villages, paiyur and Nedungal. The results suggest that technical efficiencies ranked from 0.43 to 0.55 with the overall mean value of 0.52. the management practices such as feeding, breeding, and health care are found to affect milk yields for all categories of farmers. Observed feeding practices suggest that farmers may be over-feeding cheap green fodder and under-feeding more expensive concentrates. In addition, the results suggest that excessive utilization for labor may have a negative impact on productivity where as herd size seems to have no significant effect on the productivity of dairy cows. The sum of the production elasticities range from 0.19 to 0.60 indicates the existence of decreasing return to scale in all the categories of farmers.

Shanmugam K.R. and Venkataramani A. (2006) in their work, “Technical efficiency in Agricultural Production and Its Determinants : An Exploratory Study at the District Level”, have analysed district level technical efficiency and its determinants for 1990-91. Using the stochastic frontier production approach, the authors found that Indian districts have a mean technical
efficiency of 79 percent, indicating that, on an average, agricultural output can be increased by about 21 percent with existing resources. In nearly half of the sample districts (123 out of 248), TE values lie below 80 percent. Of this set 84 districts are spread across four states: Uttar Pradesh (38), Madhya Pradesh (27), and Maharashtra (17) and Rajasthan (12). These states stand to gain the most from policy interventions towards improving technical efficiency.

This study has shown that health, education and infrastructure can be powerful drivers of efficiency at the district level. The findings with respect to health are in line with the burgeoning literature, which suggests that health can act as a strong engine for economic growth and poverty reduction.

The study has also shown that the relative importance of the determinants of technical efficiency across districts depends greatly on environmental factors such as agro-climatic zones, technical factors (such as irrigation regime), and crop mix.

In this study certain limitations are there. The major issue is that the firm level efficiency concept has been applied to district level data, and that they use data aggregated across all crops. Nevertheless, the present results can be interpreted as indicative aggregative efficiency measures of all farms within the concerned districts. Moreover they feel that aggregate level studies, such as their, can greatly complement firm level studies in the formulation of appropriate efficiency generating policies.

study revealed that the traditional average response function, which does not account for technical inefficiency of production, was not an adequate representation of the data. Also it was found that the Cobb-Douglas functional form is not an adequate representation of the data. The technical efficiency showed wide variations across sample farms ranging from 0.24 to 0.99 in the last year of the study period. The results also show that the farm specific technical efficiencies estimated are time varying and tend to decline over time. The mean technical efficiency declined from 0.80 in first year to 0.72 in the last year, which indicates that average technical efficiency regressed / deteriorated through years in paddy production. Although there were high relative frequencies of the technical efficiency above 0.90, there were also some farmers who were quite poor in their technical efficiency performance. The mean level of technical efficiency over the years ranged from 0.35 to 0.99 with overall mean technical efficiency being 0.77. Thus, the study indicates that there is a scope to improve the productivity of the crop with the given level of inputs use and technology. If the efficiency is improved, farmers will gain considerably in terms of higher profits. Further, the technical efficiencies of production of farmers are significantly related to age and year of observation. However, the inefficiencies of paddy production are not significantly related to schooling and land. There are certain other variables such as rainfall data, extension services, access to credit, research and development, farmers' training etc., which may be important to be included in the inefficiency effects model. But, because of lack of information / data, these variables have not been modeled in inefficiency effects which could have provided an insight into the policy frameworks.

Shan, B. K and K. Siva Reddy (2006), has studied on the topic, “An Empirical Analysis of Technical Efficiency of Commercial Banks in India.” This study examines the effects of deregulation on the technical efficiency of commercial banks in India. Stochastic Frontier
Approach (SFA) with specification of Cobb-Douglas Production is employed to estimate the technical efficiency of commercial banks in India. Unbalanced panel data of 90 Indian commercial banks were considered for the analysis. The empirical results revealed that, in general, the technical efficiency of commercial banks increases during the post reform period. Public sector banks achieved relatively highest followed by foreign banks and private domestic banks in terms of mean technical efficiency. This is due to its extensive geographical coverage, strong capital base and rational response to the reforms. Further, efficiency of all the selected outputs of Indian commercial banks is increasing except advances. The inefficiencies are increasing in advances due to shifting of banks operation from tergate oriented, subsidized and risk based priority sector to to profit oriented such as industrial, educational, home loans etc. With reference to all the output cases, public sector banks seem to be relatively more efficient than its counterpart’s except in net interest income. However, foreign banks are more efficient in terms of net interest income due to its quality of customer services and their principal motive to get profits. Further, the study revels that the private domestic sector banks seem to be relatively less efficient than its counterpart’s due to their weak capital base, centralized branch network and corporative ownership. Besides the analysis revealed that Indian banks, on an average, have produced output below 60 percent of their potentialities. Hence, this study calls for policy options such as encouraging mergers, instituting penalty for weak governance, bringing down nonperforming assets and amendments in labour laws to reduce inefficiency in their operation.

Guyomard, H. et. al. (2006) has studied on the topic, “Technical efficiency, technical progress and productivity change in French agriculture: Do subsidies and farms’ size matter?” This paper aims at investigating the influence of income support direct aids on productivity change for French crop, beef and dairy farms, based on individual farm data over the period 1995 to 2002.
In order to investigate the impact of subsidies on French farms' productivity changes, Malmquist indices have been calculated. Malmquist productivity indices present the advantage of a possible decomposition of productivity change into efficiency change and technological change. Efficiency change measures the change in the ability of making the best use of the available technology, while technological change refers to an improvement or worsening of the state of technology. In addition, Malmquist indices do not require data about prices, by contrast with other productivity indices. The influence of subsidies is investigated in a second-stage regression. Technical efficiency scores, indices of technical efficiency change, of technological change and of productivity change, respectively have been regressed over a set of explanatory variables, including variables representing the subsidization. Data are extracted from the French FADN (RICA) for the period 1995 to 2002. Three categories of farms are considered corresponding to farms specialized in crop, beef meat and dairy production, respectively. After creating balanced samples over the whole period, and cleaning for missing and inconsistent data, the sample sizes are of 725 for crop farms, 102 for beef meat farms and 268 for dairy farms. Input-orientated Malmquist indices have been calculated with DEA, based on a multi-output multi-input model. Three aggregate outputs have been considered: crop output (mainly cereals, oilseeds and protein crops), livestock output (meats, milk, eggs, etc.), and other output (live animals and manufactured products such as processed fruit, vegetable and oil products for instance). Four inputs have been distinguished: agricultural area in hectares, labour in annual working units (AWU), the depreciated value of total assets for the capital factor and intermediate inputs. The three outputs and intermediate inputs are in value and have been deflated by relevant price indices (base 1995). This paper first investigated productivity changes experienced by French farms over the period 1995 to 2002. Using FADN data for crop, beef meat and dairy
farms, Malmquist productivity indices were calculated using DEA and decomposed into technical efficiency change and technological change. Results suggest that over the 1995-2002 period, annual average growth rates of efficiency, technological change and productivity are low for the three categories of farms. The decomposition of productivity into its two components shows that technological progress is the dominant force for the three categories of farms, notably for dairy farms. Average technical efficiency improves for crop farms but deteriorates for the two classes of animal farms. In a second-stage regression, they investigated whether there are significant influence of farms’ subsidies on technical efficiency and on changes in productivity, technical efficiency and technology experienced by French farmers from 1995 to 2002. Their results interestingly show that CAP direct payments expressed as a share of farm revenue have similar impacts for all three types of farms: they influence negatively technical efficiency scores but positively changes in both technical efficiency and in productivity. Moreover, they favour technological progress for crop farms. In other words, our empirical results indicate that French farms that are more supported are less efficient, conform to expectations and to empirical results obtained in other studies. However, more supported farms would have experienced higher improvements in technical efficiency and higher productivity growth over the 1995-2002 period.

Amos T.T. (2007) in his work, “An Analysis of Productivity and Technical Efficiency of Smallholder Cocoa Farmers in Nigeria”, has analysed the productivity and technical efficiency involved in cocoa production in Nigeria was estimated using the stochastic frontier production function analysis. The study relied upon primary data generated during the 2003/2004 production season. Data were collected through the use of a set of structured questionnaire administered on two hundred and fifty cocoa farmers in five local Government Areas of Onodo State, Nigeria. Result of the analysis showed that farmers were experiencing increasing returns to scale in the
use of the farm resources. The efficiency level ranged between 0.11 and 0.91 with a mean of 0.72. There existed some inefficiency among the sampled farmers. The major contributing factors to efficiency were age of farmers, level of education and family size. The study observed that there was an opportunity for increase in farmers efficiency and concluded that policies that would directly affect these identified variables should be pursued vigorously.

Kolawole Ogundari and Ojo,S.O. (2007) Federal University of Technology Akure Nigeria has published an article, “Economic Efficiency of small Scale Food Crop Production in Nigeria: A Stochastic Frontier Approach”. In their study they examine the overall efficiency of small holder croppers in Nigeria with a view to examine the productive efficiency of food crop production in the country. Data were collected from 200 farmers selected by using multi-stage sampling technique and analyzed by using descriptive statistics, stochastic frontier production and cost function models. The return to scale (RTS) for the production function revealed that the farmers adopted in the irrational zone (stage-1) of the production surface having RTS of 1.113. The mean technical allocative and economic efficiency of 0.733, 0.872 and 0.684 respectively were obtained from the data analysis indicating that the sample farmers were relatively very efficient in allocating their limited resources with allocative efficiency appears to be more significant than technical efficiency as a source of gain in technical efficiency. The result of the analysis indicate that presence of technical inefficiency and allocative inefficiency had effects in the food crop production as depleted by the significant estimated gamma coefficient of each model. The generalized likelihood ratio test and the predicted technical and allocative efficiencies are within the farmers.
Idiong, I. C. (2007) in his study, "Estimation of Farm Level Technical Efficiency in Small scale Swamp Rice Production in Cross River State of Nigeria: A Stochastic Frontier Approach," he has studied on Cross River State, an important rice producing state in Nigeria. From 18 Local Government Areas of the state 5 are known of rice cultivation. A multistage sample technique was adopted in selecting 56 farming households in 10 communities in two Local Government Areas (Obubra and Obudu) from 5 rice producing local government areas in the state. A cost intensity method was used in data collection. The farmers were visited on fortnightly basis to collect information on inputs used in production as well as output of harvested paddy. Information on some socio-economic characteristics of the farmers were also collected. Data collection lasted from July 2004 to January 2005. The data obtained were analyzed using both descriptive and inferential statistics. A stochastic frontier production function that incorporated inefficiency factors was estimated using Maximum Likelihood Estimation (MLE) technique to obtain farm specific technical efficiencies as well as their determinants. A generalized likelihood ratio test was carried out to ascertain whether the rice farmers were fully technically efficient.

His study results that the productivity of rice farmers can be raised either by adoption of improved production technologies or improvement in efficiency or both. But with the low rate of adoption of improved rice technologies by farmers in Nigeria, improvement in efficiency becomes the best option in productivity enhancement in the short run. As a result of the near absence of empirical information on farm-level technical efficiency in small scale swamp rice production in the country generally and Cross River State in particular, a Stochastic Frontier function that incorporated inefficiency factors was estimated using a Maximum Likelihood technique to provide estimates of technical efficiency and its determinants using data obtained from 112 small scale swamp rice farmers in Cross River State. The results indicate that, the rice
farmers were not fully technically efficient. The mean efficiency obtained was 77 percent indicating that there was a 23 percent allowance for improving efficiency. The result also shows that, farmers' educational level, membership of cooperative/farmer association and access to credit significantly influenced the farmers' efficiency positively. The implications are that policies that would encourage educated persons to form and join cooperatives and provide them with easy access to formal credit should be made and implemented in State.

Bravo-Ureta, B. et al. (2007), in their study, “Technical efficiency in farming: a meta-regression analysis”, they have used a meta-regression analysis including 167 farm level technical efficiency (TE) studies of developing and developed countries was undertaken. The econometric results suggest that stochastic frontier models generate lower mean TE (MTE) estimates than non-parametric deterministic models, while parametric deterministic frontier models yield lower estimates than the stochastic approach. The primal approach is the most common technological representation. In addition, frontier models based on cross-sectional data produce lower estimates than those based on panel data whereas the relationship between functional form and MTE is inconclusive. On average, studies for animal production show a higher MTE than crop farming. The results also suggest that the studies for countries in Western Europe and Oceania present, on average, the highest levels of MTE among all regions after accounting for various methodological features. In contrast, studies for Eastern European countries exhibit the lowest estimate followed by those from Asian, African, Latin American, and North American countries. Additional analysis reveals that MTEs are positively and significantly related to the average income of the countries in the data set but this pattern is broken by the upper middle income group which displays the lowest MTE.
Tchale, H. (2007), "Technical efficiency of maize farming in Malawi. A bootstrapped translog frontier", has measured the level and determinants of technical efficiency of maize based smallholder farmers using a bootstrapped translog stochastic frontier that is a posteriori checked for functional consistency. The results show that higher levels of technical efficiency are obtained when farmers use integrated soil fertility options compared to the use of inorganic fertilizer only. With respect to the policy variables considered in the analysis, access to agricultural input and output markets, credit provision and extension services strongly influence smallholders' technical efficiency. There is a need to strengthen these public policy issues in order to effectively address the efficiency of Malawian agriculture and its impact on poverty by ensuring sustainable soil fertility management.

Onyenweaku, C. E. and D. O. Ohajianya (2007), designed a study to measure the level of technical efficiency and its determinants in rice production in South Negeria using a stochastic frontier production function. Multi-stage random sampling technique was used to select 160 rice farmers using the cost-route approach. In the result, the estimated farm level technical efficiency is found to be varying from 17.19 percent to 93.13 percent with a mean of 65.06 percent technical efficiency. The wide variations in the level of technical efficiency indicate that ample opportunities exist for farmers to increase their productivity and income through improvements in technical efficiency.

Ukoha, Oji O et al (2008), in their article, attempted to determine the technical efficiency of poultry egg production in Nigeria. A sample of 60 poultry egg farmers was selected by multistage sampling procedure and Data were collected by using a structured questionnaire. A stochastic production function was specified and estimated, using maximum likelihood
estimation. The result showed that labour, farm size, feedcost, capital and utilities have a positive and significant impact on output and mean technical efficiency was found to be 0.58 with a range of 0.43 to 0.76. Farm size, extension contact, credit, feed intake, drugs and level of education and farming experience had positive and significant impact on technical efficiency. On the contrary, labour had a significant negative impact on technical efficiency. Recommendations include increase in farm size, provision of more extension services and increased access to credit, medication, education and cheap feed.

Stefan, O., Michael, T. (2008), have studied on, “An Examination of Economic Efficiency of Russian Crop Output in the Reform Period” This paper examines economic efficiency of Russian corporate farms for 1995-98. Economic efficiency declined over the period, due to declines in both technical and allocative inefficiency. According to the average technical efficiency scores, Russian agricultural production could improve from 17 to 43 percent according to DEA and SFA analysis, respectively. The efficiency scores show that Russian agriculture presently uses relatively too much fertilizer and fuel and too little land and labor. Russian agriculture inherited machinery-intensive technology from the Soviet era, which may be inappropriate given the relative abundance of labor in the post-reform environment. Investment constraints have prevented the replacement of old machinery-intensive technology with labor intensive technology.

Ajibefun, I. A. (2008) has studied on, “An Evaluation of Parametric and Non-Parametric Methods of Technical Efficiency Measurement: Application to Small Scale Food Crop Production in Nigeria.” The objective of this study is to compare the estimation ability of the parametric and non-parametric techniques of frontier models in technical efficiency analyses. In
For this study, Stochastic Frontier Production Function (SFPF), for parametric technique and the Data Envelopment Analysis (DEA), for non-parametric technique were estimated and compared. Results of analysis indicate that the sample farmers have varying level of technical efficiency, ranging from 0.22 to 0.87 for both techniques. Also the results for both parametric and nonparametric techniques showed that age and education level of sample farmers have significant influence on the level of technical efficiency. The estimated mean technical efficiency
do not vary widely with the method used, though some differences in magnitude of individual technical efficiencies are noted for both techniques. Finally, a combination of the technical efficiency scores obtained from the two different methods is proposed as a better set of scores.

Kent, O., Linh, Vu., (2009), has studied on, “Productivity growth, Technical Efficiency and Technical Change on Minnesota farms” Changes and trends in farm productivity have been of intense interest to many involved with agriculture. This study used data envelopment analysis (DEA) to estimate the output-oriented Malmquist total factor productivity (TFP) index from panel data for 1993-2006 for farms in Southern Minnesota. Bootstrap methods were used to estimate confidence intervals for the productivity, efficiency change and technical change indices. The model included three inputs (labor, land and immediate expenditures) and six outputs (corn, soybean, milk, hog, beef, and nonfarm income). Productivity growth was found to be positive during the period, with an average annual productivity growth of 6.6 percent. However, TFP growth has been slowing down in recent years and indeed negative in 2000/01, 2002/03 and 2005/06. In the second stage of the analysis, the significance of various factors that might affect farm performance was estimated. Farm size (as measured by the log of farm income) was correlated with higher productivity which may help explain the increase in farm size in Minnesota farms in recent years. Government subsidies were found to have a negative impact on farm performance supporting the argument that agricultural subsidies may create disincentives for farmers to improve their productivity and efficiency. A higher nonfarm income ratio was positively related with higher productivity growth. A higher proportion of hired labor has a negative effect implying family labor is more crucial than hired labor in improving productivity.
Djokoto, Justice G. (2011), has studied on the topic “Technical Efficiency of Agriculture in Ghana: A Time Series Stochastic Frontier Estimation Approach”. In his study a Cobb-Douglas production was fitted to time series data, 1961 to 2010 using stochastic frontier methodology. All factors of production possessed the *a priori* signs except land and seeds, whilst all except seeds variable were significant at 1% level. All the capital variables were output inelastic. Labour was elastic to output; with elasticity of 1.28. The sum of the elasticities equalled 1.74, indicative of increasing returns to Ghana’s Agriculture over the period. The estimates of technical efficiency had a mean of 82% with a minimum of 59% and maximum of 96%. Efforts remain to make up for the 18% inefficiency using the current technology. With a negative relationship between land and Agricultural output, coupled with the increasing population and increasing need for non-agricultural land uses, the need to adopt land productivity enhancing practices is necessary.