Chapter - 2

REVIEW OF LITERATURE
Some of the earlier studies on various aspects of coffee plantation have been briefly reviewed here. The earlier literature provides a basic strategy for the present study in order to make it more comprehensive.

Awataramani and Chokkanna (1965) reported the results of simple manorial trials conducted for three years in 46 estates located in various agro climatic regions growing coffee under mixed shade. The trend was in favour of application of balanced fertilizer i.e. N+P+K @ 67:37:45 kg /ha rather than Nitrogen alone or in combination with either Phosphorus or Potassium.

Ananth et al. (1966) reported Zinc deficiency in coffee in almost all the coffee growing tracts of south India. Foliar sprays of Zinc Sulphate at 0.25% concentration has over come the deficiency and normal healthy leaves are seen to appear from the affected plant. Foliar application was found better in correcting the deficiency compared to soil application.

Awatarmani and Mir Azizuddin (1973) found out that green revolution has occurred in coffee is shown by figures of production and yield/ha during the past 25 years. A yield index of 685 and a production index of 821 speak for themselves. This great forward leap has become possible due to scientific advances and advisory service of Research Department of Coffee Board.

Alfanso and Mestre (1976) conducted studies on N, P and K fertilizers effect on coffee yield in Colombia. Each one of the fertilizer elements was applied at the rate of 0, 120 and 240 kg per hectare. The field trials were conducted for six years in eight different locations of coffee growing areas. The results indicate that Nitrogen increased coffee yields in all the locations even in those with high soil organic matter content. The application of Potassium increased the yield in five out of eight locations. The data indicated a relationship between coffee yield and Potassium content in soil. There was no effect of Phosphorus on yield.
Ananda Aalwar (1985) conducted studies with different proprietary macro/micro nutrient formulations to know their effect on yield and quality of coffee. Ten various formulations were evaluated. The results indicate that the coffee yield and quality was not influenced by the use of these formulations. However, numerical increase in yield was observed with Multiplex, Zimag and Agromin formulations.

Ananthanarayan and Ravindra (1998) reported that the soil reaction is extremely important in evaluating the production potential of coffee. The total potential acidity in coffee growing soils is high due to high content of organic matter and clay while the exchange acidity of soils is much less. The aluminum saturation varies from 26.4 to 80.7% in soils of Chikmagalur district cropped to coffee. For the purpose of lime recommendation Calcium saturation method was found better than the buffer method.

Chandler et al. (1968) computing the costs and returns of coffee plantation in Kenya, reported that an average family could manage 4 acres of coffee intensely so as to get a specified amount of returns. Raising a cash crop as an intercrop with coffee and incentive payment by government reduced the costs markedly.

Chengappa and Muralidharan (1980) interpreted the pricing efficiency of Indian coffee markets in terms of spatial integration. The bivariate correlations of monthly prices among geographically separated markets at pool sale, wholesale and retail levels used as indices of market integration showed a high degree of pricing efficiency. The relative efficiency was maximizing at pool level because of better control by the Coffee Board. The efficiency was in the declining order from wholesaler to retailer for want in adequate control by the Board. The location of distribution points and institutional constraints of differential sales tax were found to influence the movement of prices in unison.
Chengappa and Muralidharan's (1981) analysis of variance of prices secured for all lots of coffee sold at pool waste auction during a month revealed the importance of grading storage locations and auction centers in explaining the price variation. The extent of variation due to the latter two factors, is interpreted in terms of differential sales tax in important consuming states. The advantages of conducting auctions at Bangalore and Coimbatore centers are absent at Vijayawada and hence the need to look in greater detail at the cost economy, for its possible elimination in view of mounting marketing costs is pointed out. There is a need for a rational grading based on consumer needs.

Chengappa (1981) studies the growth rate of area, production and productivity of coffee in India. Linear model of the type $Y(t) = a + bt$ and exponential model of the type $Y_t = ab^t$ were used to work out the growth rates. The exponential function indicated a good fit of the annual compound growth rate of production with 5.68% for arabica and 7.4% for robusta, their combined growth rate being 6.1%.

Debnath and Sarkar (1967) made an analysis of the economic structure of coffee cultivation. Using the data collection from the Coffee Board they observed that the bigger estates were generally more efficient than smaller ones. According to the authors, to earn an average net annual income of an agricultural family in India, the size of a coffee estate has to be between 7 and 15 acres. They further suggested that to increase the efficiency of production the emphasis must be placed on improved techniques of cultivation.

D'Souza (1971) described the factors determining fertilizer requirement of coffee namely (1) Plant materials and its inherent qualities (2) Clean coffee yield (3) Quantum and nature of bearing wood (4) Light intensity along with elevation and aspect of state (5) Data on soil and leaf analysis to determine the status availability of major and minor nutrients (6) Structure and texture, drainage and
moisture holding capacity of soils (7) Organic matter status of the soil and nature of rhizosphere microflora (8) Residual and cumulative effects of previous input of soil amendment and fertilizers are presented.

D'Souza (1973) in his study says that the role of management has assumed great importance in coffee cultivation in South India and it is the manager's ingenuity which today the most decisive and challenging estate performance ending pressures of increasing cost. The most important management factors which influence crop response from a given field are various and age of plants, fertilizer and spray treatment, pruning and liming practices and shade intensity.

Dhruvakumar and Krishnamurthy Rao (1982) studied the Manganese status of soils cropped to coffee in Koppa Zone of Chikmagalur district. Available Manganese ranged between 0.5 and 60 ppm, while active (available + easily reducible) Manganese varied between 40 to 1260 ppm. Out of the samples analyzed, about 95.8% had a high content of active Manganese and had the potential to cause toxicity.

Dass (1985) studied the trends in the unit values, quantum and export value of coffee from India. These trends were computed for two periods - one pertaining to the period 1956-57 to 1972-73 and the other to 1973-74 to 1982-83. The results showed that the annual compound growth rate of unit values of coffee at 11.33% during the second period was much higher than the first period (1.9%). However, the annual compound growth rate for quantum of export was at 9.5%. During the first period it was much higher than the second period at 5.8%. The annual compound growth rate in the value of coffee export at 11.4% during the first period, was due to increase in the quantum of exports. During the second period the growth rate of 17.2% was mainly due to the increased values.
Damodaran (1999) study of the Indian coffee industry for the two decades, promises a stage of high excitement, opportunities and challenges. Of central significance to India’s coffee industry has been the WTO Agreements on agriculture-'Trade Related Intellectual Property Rights’ (TRIPS) and The ‘Agreement on Technical Barriers to Trade’ (ATBT). The WTO Agreement on agriculture which calls for reduction of tariff and non-tariff barriers poses major challenges to Indian coffee, which may have to face competition from imported coffee and from other origins. The TRIPS with its accent on industrial patents and sui- generis legislation on plant variety production and geographic indications can alter the systems of cultivation of coffee. The ATBT with it’s emphasis on technical standards such as ISO 1400 also offers challenges by way of informational audits and certifying systems of Indian coffee. This paper examines the impact of these WTO agreements on India’s coffee industry in the coming millennium.

Damodaran (2001) in his study says that characteristic of sustainable coffee in India has been its ecosystem characteristic, its eco ‘Culture’ its relatively high in-situ bio-diversity, its natural diversity and its propensity to sustainably manage its boundaries with wildlife rich protected forest areas. However, care has to be taken to ensure that these supreme advantages are not last through ‘Technification Tendencies’ which could transform this ecosystem into “production machines”. The logical course would be to launch a programme for detechnifying coffee R&D. Such a detechnification approach could perhaps form the first step towards translating the dream of sustainable coffee into a “tradable” proposition.

D’ Souza, G. F., Mallikarjun, G. Awati, D., Venkataramanan, C.G., Anand and R. Naidu (2002) conducted a study to identify the best source of fertilizers for better establishment of young coffee of Sln. 12 and Sln.9 after transplanting to the field. The sources of fertilizers tested were Factomphos, Urea + Single Super
Phosphate (SSP) + Murate of Potash (MOP) and Ammonium Sulphate + Diammonium Phosphate (DAP) combinations by giving the application during the pre and past monsoon periods @ 25 and 50 grams per plant per application respectively during first and second year. The result of the study indicated significantly (p=0.05) higher percent increase in growth characteristics such as plant height, number of primary branches and stem girth coupled with improved bush spread of young coffee in both, the cultivators applied with Factomphos than other sources of fertilizers. Higher increase in net Photosynthesis and Carboxylation efficiency was also observed after twenty and forty days of Factomphos application as source of fertilizer compared to rest of the fertilizer sources. It was concluded that Factomphos would be very much useful as a source of fertilizer to improve the growth and development of young coffee for better establishment.

Gemtessa (1991) evaluated the performance of Ethiopian coffee exports during the pre-revolution and post- revolution periods. The exponential growth model of the form \( Y_t = ab^t e^{ut} \) was employed. The results show that export growth in the pre-revolution period was lower (1.61%) than that in the post- revolution period (1.77%).

Gregr and Sakango (1991) studied the effect of a slow release fertilizer containing N, P\(_2\)O\(_5\) and K\(_2\)O at 11, 10 and 11.5% respectively, plus Mg, Fe, Zn, Mo, B, Mn and Cu Fertilizer on nutrient uptake by coffee plants. One-month-old arabica seedlings grown in pots containing a soil, peat and sand mixture of pH 6.2 were supplied with the slow releasing fertilizer and with a traditional NPK fertilizer as control in equivalent mounts. The plants (aerial parts) were sampled 3 times during the growing season. As compared with NPK fertilizer treatment, plant dry matter and N, P, K, Ca and Mg concentration in treated plants were
lower at the first sampling, but much greater by the final sampling compared to controls.

Gopinandhan, T.N. Paneer, Selvam, P. Velmourogane, K. and Naidu, R. (2001) studies show that there is no alternate use for green coffee other than consumption as beverage. Rejection of mould contaminated coffee consignments by importing countries cause loss of export for the producing countries and such a rejected coffee lot may be consumed with in the producing countries. Thus, strict adherence to the above said guide lines/recommendations which are otherwise termed as Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP) and Good Hygenic Practices (GHP) help in achieving effective limitation and control of mould mediated quality loss in coffee.

Hyuha (1982) examined the world demand for coffee with particular reference to East Africa. Since the United States of America is a major consumer, it was used as a proxy for the world market. The world coffee economy was reviewed noting that U.S coffee imports were declining, while non-traditional consumers like Japan had increased their import of coffee. The results of regression indicated that East African coffee was tending to income elastic but price inelastic like any other agricultural commodities.

Herbert Desola (2001) studies the extremely low prices generated by the inelasticity of demand for the beans, make it logical and viable for coffee producing countries to extract and remove excess inventory triages with relatively modest financial resources contributing to alleviating the present market imbalance.

Iyengar (1953) has reported that for an average crop of 275 kg of clean coffee per acre, a balanced fertilizer mixture containing 14 kg of Nitrogen, 20 kg of Phosphorus and 30 kg of Potassium / acre was suggested.
Iyengar (1959) found out that in India the area under coffee production is about 2.5% of the world's area and production is only about 1% and the present area of 2,50,000 acres produces 40,100 tonnes, internal consumption being 25,000 tonnes, we can export only 15,000 tonnes. Since prices have increased considerably, the ratio between cost of production and prices realized does not seem to have altered materially. Our present yield is 330 lb/acre for arabica and 400 lb/acre for the robusta with 375 lb/acre for the two species together. The increase in yield can be done to a great extent by good manuring. A balanced mixture containing NPK in the ratio of 2:3:4 produce more crop, than a mixture containing more Nitrogen than Phosphorous and Potassium. The mixture applying 50 N, 75 P, 100 K kg/acre is enough to produce an average crop of 7-8 cwts / acre under normal conditions.

Iyengar (1971) reviewed the results of the fertilizer trials conducted in coffee. Based on these trials the nutrients and their ratio were fixed as 2:3:4 NPK. The results of the trial conducted for 12 years indicated that (1) Application of NPK fertilizers has given higher coffee yield than no fertilizer application (2) Application of Nitrogen at levels greater than 40 lb / acre increased the coffee yield (3) Phosphorus and Potassium gave good response only in the presence of Nitrogen (4) Application of bulk manures at comparative levels was not economical.

Indira (1988) studied the rate of growth in internal releases of Indian coffee in comparison to the growth rate in production and exports. The compound growth rates were calculated for two time period: period-I ranges from 1953 to 1969 and period-II for 1969-81. Between 1953-69, when production increased at an annual rate of 6.16%, consumption increased at 3.13%. The annual rate of increase in production, internal releases and export for the second period was much smaller relative to the first period. Production increased at an annual rate of 4.32% while
internal releases and export recorded a growth rate of 2.44% and 5.79% respectively. For the entire period, these rates were 4.38%, 2.34% and 7.3% in that order.

Indira and Giriyappa (1993) found out that factors influencing coffee consumption in India are studied in order to suggest measures to increase coffee consumption in India. Multiple Regression Analysis was used with consumption of coffee as the dependent variable and income, price of coffee, tea, sugar, taste and lagged consumption as independent variables. Results indicate that previous consumption, which was considered to represent coffee drinking as habit, price of coffee and tea are the factors influencing coffee consumption. Generic promotion, increase of internal release through co-operative societies and propaganda units of Coffee Board is suggested to improve the coffee consumption.

Jamsheed Ahmed and Sreenivasan (1990) examined the five exotic collections of robusta and were assessed for out turn ratios at different stages of processing under sun dry and washed method. Under dry processing, 41.8% cherry, 46.7% green coffee yield was recorded. By wet processing 21.8% parchment and 86.6% green coffee was obtained. Differences in out turn among the accession were statistically not significant. Correlation tests between crop level and out turn, ‘A’ grade beans and out turn and grade ‘A’ beans with yield level were under taken. Crop levels was negatively and significantly correlated with outturn, bean size was positively and significantly correlated with yield level and finally out turn showed positive significant relationship with yield in two accessions (S. 1902 and S. 1932) only. One accession did not (S. 1977) show any relationship between the parameters processing methods and specific effects on out turn.

Jamsheed Ahmed et al. (1992) in his study say that correlations were worked out to determine the relationship between early rainfall, week of
occurrence of blossom rain and its time to occurrence and previous year’s yield on production levels of arabica and robusta. Data on rainfall and crop of 20 consecutive years of two farms of research department was statistically analyzed. Analysis showed no relationship between the above factors and yield in arabica; while in robusta a significant and positive impact of week of occurrence of blossom of rainfall on crop level was found at both locations indicating that delayed showers would result in loss of crop. At one farm, March rainfall and previous year’s December rain fall showed positive impact on robusta crop level. While rainless interval between blossom and backing showers have significant negative effect on yield, the lack of influence of factors on arabica yields at both locations is attributed to sufficiency of blossom rainfall and its time of arrival for this coffee in most of the years of study.

Krishnamurthy Rao and Ananda Alwar (1984) studied the available Sulphur status of soil in Mudigere and Koppa region of Chikmagalur district cropped to coffee. Results revealed that about 70% of the soil samples analyzed had Sulphur available well above the critical limit. It also revealed that there was no immediate possibility of Sulphur becoming a limiting factor due to high use of fertilizers. This is perhaps due to high organic matter status of coffee soil and incidental uses of Sulphates of Copper and Zinc in coffee plantations.

Krishnappa Naik et al. (1988) reported that about 50% of the soil cropped to coffee in Chikmagalur district is acidic in nature requiring the application of lime. Most of these soils are low in percent base saturation and therefore low in Calcium and Magnesium. The soils are rich in organic matter, poor in available Phosphorus and medium to high in available Potassium. Since the entire coffee area receives very high rainfall during monsoon months, salt content is low in these soils signalling the use of Sulphur, Magnesium and Zinc. It was observed that high yields are registered where the soil PH is normal.
Krishnamurthy Rao (1991) reported that in India coffee is being grown invariably under mixed canopy of shade comprising leguminous and non-leguminous shade trees. It has been estimated that under this mixed canopy shade, approximately about ten tonnes of leaf litter is added annually per hectare. This turns around to be 100 kg Nitrogen, 3-40 kg Phosphorus and 45 kg of Potassium per hectare per year.

Kharche (1996) reported a range of Organic Carbon of top 25 cm as 1.5-2.9% in some coffee growing soils of Chikmagalur and Kodagu districts and noticed a positive significant correlation between arabica coffee yield and soil Organic Carbon. The study revealed that soil Organic Carbon content of 1.5-2.4% as ideal for arabica coffee cultivation.

Lima and Malavolta (1998) conducted studies on the effect of Zinc and Boron in arabica coffee. The results indicated that the addition of Zinc caused an increase in Boron content of leaves. The positive effect of Zinc was significantly greater at the higher rate of Zinc application. Based on the studies they concluded that the soil DTPA Zinc of 2.1 ppm and corresponding leaf Zinc of 12-14 ppm as optimum for coffee cultivation.

Lakshmi Venkatachalam (2004) in his study of the short time available had been able to raise concerns about the future of coffee to a level that go beyond the immediate concern, it is prices and returns. In our pre-occupation with the immediate concern, it is quite natural to lose sight of the larger picture. The global coffee community and not in the least the Indian coffee grower needs to reorient himself to change his perspective to face the daunting challenges in our quest for sustainable solutions.

Mutuku (1966) in a case study of 53 farms in Nyeri district in Kenya in 1962 observed that 42% of the cost of establishment was spent in the first year
itself. The amount of hired labour varied with the farm household, depending upon
their availability for farm work and their financial ability to hire labour, on small
farms, expenditure on labour ranked very high. However, coffee commended a
high level of profit on small farms in Kenya.

Mathew and Azizuddin (1968) studied the nutrient status of coffee soil of
South India and its influence on crop yield. The highest level of available
Phosphorus and Potassium and lowest acidity were seen in Coorg district, while
soils with low fertility status and maximum acidity were observed within Kalpetta
zone of Kerala state. High yield was generally associated with higher nutrient
status particularly Phosphoric acid.

Madappa (1970) worked out the cost of production of coffee on estates
exceeding 10 acres, for the year 1964-65. Here also the holdings below 10 acres
were not taken into consideration. Unlike in the previous studies, Madappa takes
into account the yield of only one year (1964-65). This approach therefore could
not give a true picture of the productivity of a perennial crop like coffee which
usually displays its dominant character of biennial bearing. The cost of
establishment of the plantation has been amortized, considering the cost of the
establishment of estate as equipment to Rs. 2,500 /- per acre (1964-65).
A straight line method of amortization was followed assuming the economic life
of the plantation as 40 years. The out of pocket costs were considered as working
capital and a return of 8% was provided for the working capital. Re-planting
allowance was considered at the rate of Rs.10 per 50 kgs of yield. The actual yield
figures for the year 1964-65 was taken into account in calculating the allowance.
The study brought out, that it was only in the case of cost of processing, the small
estates differed from the big estates. Further, in the analysis of cost structure on
the various categories of holding sizes namely, 10-20, 25-50, 50-100, 100-200 and
over to 200 acres revealed that the highest input-output (1.60) was in the
categories of 200 acres and above, the lowest and negative input-output ratio (0.99) was in the category of 100-200 acres, while it was 1.37 in 50-100 acres, 1.09 in 25-50 acres and 1.30 in 10-20 acres group.

Maroko (1991) studied the long term effects of Copper sprays on the Copper levels in soil and coffee plants in Kenya, where Copper was used to control bacterial blight (Pseudomonas syringae) and coffee berry disease (Glomerella cingulata). After two years there was a significant increase of both EDTA extractable and total Copper in sub soils, but no significant increase was noted in the top soil, pH of top soil increased during this period. Copper levels in roots, branches and in coffee beans was not affected by the Copper sprays, whereas Copper levels in the leaves increased. However, toxicity symptoms were not noticed in plants.

Michori (1993) attempted to construct the Nitrogen budget for coffee under Kenyan soil and climatic conditions. The study confirmed that the fruit is a major link of plant Nitrogen that contained between 39-42 per cent of total plant Nitrogen while the marketed beans removed 26-30 per cent of total plant Nitrogen. He concluded that on the input side of the budget accurate data is required in areas such as Nitrogen cycling in coffee plantations and in particular the quantity and availability of coffee plant Nitrogen recycled back to soils in pruning and weeds. On the output side of the budget many unanswered questions signifies the lack of information of Nitrogen loss under coffee. Of particular importance and not limited to Kenya is the Nitrogen loss through erosion or run off which would be expected to be large because most of the world coffee is being grown on sloppy grounds. Nitrogen loss through leaching, denitrification and ammonia volatization is also not well understood.

Mallikarjunappa (1999) studies financial express have developed a number of techniques to manage price volatility in commodities market. One of the most
important risk management techniques used world over to hedge prices risk in futures trading. In order to help the players in coffee market, a future trading in coffee is being conducted by Coffee Futures Exchange India Limited (COFEI) from June 1998. COFEI acts as a buyer of coffee. The important benefit of futures trading conducted by COFEI is that the exchange ensures guaranteed performance of the contract by the parties. A future trading of coffee is of recent origin in India and has a lot of potential. This paper examines the modus operandi of coffee futures contract and discusses the way COFEI helps in managing price risk.

Manoharan, A. Ramachandran, M. Kathireson, D. Kannan S. Srinivasan C.S. and Naidu, R. (2002) analyzed five years data on quality evaluation of twelve arabica selections and their performance at Regional Coffee Research Station. Thandigudi, Tamil Nadu, which is under north east monsoon, were subjected to analysis. The data on raw, roast, liquor and cup qualities were analysed for 5 years. In all the years, cioccie and agro were awarded FAQ to excellent cup and FAQ to good respectively, visual assessment showed variations in colour of the coffee bean of different cultivars i.e., bluish grey, brownish grey and greenish grey etc. The roast and liquor qualities of the cultivar were not having much variation with in a year but recorded slight variations between the years. The cup quality of Sln.12 (Cauvery) was FAQT to good in 1998. Sln. 8 (HDT) was FAQ to good in 1999 and Sln.11 was awarded FAQ to good in 2001. In all the years Sln. 5B was awarded FAQ and above FAQ. Sln. 6 was below FAQ to FAQ minus for 3 years (1999-2001) and it was FAQ and FAQ plus in 1997 and 1998 respectively.

Njoroge and Mwakha (1985) studied the effect of N, P, K fertilizer trials over a period of eleven years in Kenya. The results indicate that Nitrogen and Phosphorus increased coffee yield while Potassium decreased coffee production significantly. Yield response to Nitrogen was highly significant. The differences
between N x P, N x K and P x K were not significant. The liquor quality of coffee was not affected by the fertilizer treatments.

Nithya Shree and Siddaramaiah (1993) in their study showed that the overall yield-gap indexes for coffee among the planters was as high as 62.85%. This implied that there is a scope to increase the coffee yield by more than two times. Further, the yield gap in respect of robusta was relatively higher than that of arabica. Hence, there is a need to give more emphasis for the education of robusta growers. The extent of yield gap was related to application of fertilizers and liming in arabica, while it was application of fertilizers and use of sprinkler irrigation in robusta.

Njoroge (2000) based on studies conducted in Kenya reported that on an average one ton of coffee beans could remove 46 kg of Nitrogen, 8 kg of Phosphorus and 38 kg of Potassium from the soil. This coupled with losses through parchment pulp, erosion and leaching leaves the soil seriously exhausted. It is therefore necessary to apply fertilizers for vegetative growth of the trees and production of high quality coffee beans. In order to apply the correct type and rate of fertilizer and thus avoid toxicity and nutrient imbalances in the soil environment, it is better that the fertilizer recommendation should be based on soil and coffee leaf analysis results.

Oruko (1977) reported that the soils cropped to coffee in Kenya are generally well supplied with Potassium and Calcium where as they are very low in Magnesium status and deficiency symptoms are some times observed. The foliar and soil application of Magnesium fertilizers significantly increased coffee yield.

Ojeniyi (1980) studied the nutrient status of NPK treated coffee plots in Nigeria. The chemical properties of 128 soil samples collected from the surface and subsurface layers of 64 NPK treated coffee plots were analysed. The ensuing
data were compared with those from other coffee, cocoa and tropical soils of West Africa and Brazil. After seven years of NPK application to the coffee soil in Southern Nigeria, the soil was considered deficient in base elements especially Ca and Mg. Fertilizer treatments were found to effect statistically significant differences in the nutrient contents of coffee plots.

Ojeniyi and Agbede (1980) conducted studies on the influence of soil Organic Carbon on yield of robusta coffee in different Nigerian ecological conditions. Surface soil samples were collected from coffee plantations where N, P and K fertilizers applied twice in a year. The results of five years trial indicate a positive relationship between coffee yield and soil Organic Carbon content. The highest yields were obtained at 2.0 and 2.6% soil Organic Carbon content respectively.

Perkins (1949) classified the cost items in coffee production in Kenya as

a. **Essential Maintenance Cost:** They include cost incurred on cultivation, handling, pruning, spraying, shade maintenance etc. These costs are proportional to the total coffee acreage but independent of the crop.

b. **Operational Field Treatment Cost:** They include cost on green manuring, over cropping, mulching, compost application etc. These items aim at increased yield and they are proportional to the acreage treated, but independent of the crop that results.

c. **Crop Cost:** They include costs in picking, factory work etc. These costs are proportional to the tonnage, but independent of acreage.

d. **General Overhead Expenses:** They include costs on general estate maintenance, tools and implements and management. These costs are usually fairly constant but independent of yield.
On the basis of economic analysis, Perkins concluded that economic balance was heavily weighted in favour of big estates. He observed that high yield per acre and quality were the important contributory factors. He further recommended that an increase in the size of the plantation was an important economic step.

Prakash (1986) examined the growth rates of production, consumption, export, world production and imports of Indian coffee. He used a modified exponential growth function of the form \( \log Y_t = a + bt + ct^2 \), where growth = \( b + 2ct \). He indicated that the growth rate production of Indian coffee increased each year and yielded a compound growth rate of 4.51% annum during 1962-63 to 1981-82. The consumption growth rate recorded for the same period was 12.69% per annum for the exports. However, had registered a significant increase during the study period which accounted to a compound growth rate of 6.94% per annum.

Raju (1978) studied the influence of continuous use of inorganic fertilizers on the nutrient status of oxisols cropped to coffee it revealed that long term manuring had practically no effect on Nitrogen and Organic Carbon status, humus and CEC of soil. But it improved the soil fertility with respect to Phosphorus and Potassium. Total exchangeable and available Potassium and total available Phosphorus increased with increasing amount of fertilizers. The pH and exchangeable Calcium and Magnesium showed a significant decrease with simultaneous increase in exchangeable aluminum.

Raju and Deshapande (1985) studied the influence of long term fertilizer application on the available micronutrient content of soils. The results showed that continuous application of fertilizers over years brought down the pH of the soil significantly with concomitant increase in available Iron and Manganese. Extractable Zinc and Copper were not appreciably affected, possibly due to the presence of these elements. Plant analysis indicated leaf Manganese increased
considerably due to continuous application of fertilizers, no perceptible variations were noticed in leaf Iron and Copper. Leaf Zinc gradually decreased with increasing doses of fertilizer.

Raju and Deshapande (1986) studied the Phosphorus and Zinc interaction in coffee soils. The study revealed that Phosphorus even at 2400 ppm did not alter the extractable soil Zinc possibly due to the presence of Zinc mostly as organically bound or occluded Zinc in the soil under experimentation. However, the growth studies with arabica seedlings on the differentially treated incubated soils showed that leaf Zinc reduced with increasing amount of added Phosphorus, suggesting a possible interaction of P and Zn with in the plant system. The application of heavy doses of Phosphorus enhanced the leaf Phosphorus and growth of coffee seedlings despite its depressing effect of leaf Zinc. The increase in leaf Zinc and extractable soil Zinc upon the addition of Zinc sulphate indicated the possibility of soil application of Zinc salts to improve the Zinc status of soil and plant.

Raju (1986) reported that the continuous application of graded amounts of NPK to coffee gradually decreases leaf Zinc with concomitant rise in Phosphorus, Potassium and Manganese. Incubation studies and nursery trials with coffee seedlings were carried out to evaluate the influence of varying doses of Phosphorus, Calcium Carbonate and Copper Sulphate in combination with different levels of Zinc on the availability of native as well as applied Zinc, seedling growth and Zinc uptake. Application of Phosphorus enhanced the growth of seedling in spite of decreasing the leaf Zinc content. Available Zinc in soil was not influenced by added Phosphorus. Calcium Carbonate boosted the growth in combination with Zinc, though it reduced extractable soil Zinc. Copper sulphate too increased the growth without affecting either the soil Zinc or plant Zinc. Both available and total Zinc in the soil were found to have direct relationship with plant Zinc. Among the several extractants, DTPA was found to be better to assess the available Zinc.
Ramaiah and Radhakrishnan (1986) analysed growth rates in area and production of arabica and robusta in India in the past few decades revealed that robusta outstripped in area and production. The analysis of trend yields and co-efficient of variation brought out the declining rate of marginal productivity and the magnitude of year to year yield of coffee respectively. The above conclusions drawn found to be valid for the individual coffee growing states as well.

Raju and Deshpande (1987) studied Copper and Zinc interactions in coffee seedlings. Incubating soils with varying amounts of Copper and Zinc increased available Copper and Zinc significantly. Growth of arabica seedlings on treated soils did not indicate any adverse effect of Copper on Zinc uptake or vice-versa. The addition of Copper enhanced the growth of seedlings without interference of Zinc assimilation. The Copper and Zinc contents in leaf increased with increasing amounts of added Copper and Zinc suggesting that no interaction occurred between Copper and Zinc in coffee seedlings.

Ramamurthy and Raju (1987) evaluated different extractants to assess the availability of soil Sulphur cropped to coffee. The results indicated that the heat soluble Sulphur was present in higher amounts followed by Ammonium acetate and ammonium acetate-acetic acid extractable Sulphur. Sulphur extracted by bray-I reagent, 0.15% Calcium chloride or cold water was comparatively less. Correlation co-efficient worked out revealed that heat soluble Sulphur and Sulphur extracted by ammonium acetate- acetic acid and Ammonium acetate had significant correlation with plant Sulphur, bray-I extracted Sulphur had poor correlation. This study suggested that ammonium acetate could be employed to assess the availability of soil Sulphur to coffee in routine soil testing programme.

Renne (1987) estimated the supply, demand and price elasticities for the coffee. The model was estimated as four separate producers blocks, using the
annual data from Brazil, Colombia and Guatemala between 1952-81 and for the Ivory coast from 1959-81. The major findings of the study were at low price levels, demand for coffee was price inelastic; the demand for most coffee varieties was income inelastic, with coffee being considered as an inferior good in the U.S.A., Brazil was found to have a significant, although not absolute influence in determining world coffee prices.

Raju (1988) conducted studies on correlation of soil test values and coffee yield. The soil test data and the yield figures obtained in the course of soil testing programmes in various coffee zones were utilized to fix the critical levels of soil pH, available P and K for coffee. The application of Cate and Neson's procedure of non-parametric test of association indicated that the critical soil pH for coffee under South Indian conditions was 5.8-5.9. For available P and K the critical values respectively were 7 and 60-80 ppm. Further the correlation studies indicated a positive linear correlation between added nutrient elements and coffee yield. Soil reaction and available K were found to have a positive correlation with yield where as soil P failed to show any relationship.

Radhakrishnan (1988) in his study productivity response, surfaces, functions are fitted to field survey data of robusta coffee with yield, nutrient quantity and age of the bushes as variables. The major objectives are to indicate the choice of Polynominal functions to study the yield response in different regions. The results bring out the importance of age of the bushes as a variable in the functional analysis. Among, the two types of the functional forms, the bush-based responses function in which the above variable is expressed in kg/ha. The yield maximum of nutrients and age groups are derived for two regions from the respective functions. Given the levels of inputs yield response varies in the two regions studied. Region wise bush-based fertilizer nutrient application are the major suggestions emerged out of this study.
Radhakrishnan and Ramaiah (1990) the study was proved that there exist a yield gap of more than 700 kg/ha of clean coffee in small holdings of Kodagu districts. Yield can be substantially improved and yield gap could be bridged by increased fertilizer use in the case of robusta and increased fertilizer use coupled with adequate plant protection and soil conservation measures in the case of arabica. These factors in turn depend upon availability of capital and technical information.

Ramamurthy (1998) studied the effect of different levels of S on growth of coffee seedlings. Sulphur at the rate of 20, 40, 60 and 80 ppm in elemental form had no significant effect on leaf Sulphur, available soil Sulphur or growth parameters of coffee seedlings. The Sulphur requirement of different coffee cultivars was studied by Ananda Alwar and Krishnamurthy Rao (1992). The quantity of Sulphur required by different cultivars of arabica to produce one ton of clean coffee varied between 2.3 and 3.5 kg.

Raghuramulu, Y. and Naidu, R. (2001) found out the technology is already available on sustainable management of plant growth soil physical and biological health nutrition, pests and diseases in coffee plantation. There is a need to integrate all these components and study their impact of coffee and its environment as well as the quality of the produce vis-à-vis intensive farming methods. This would help in standardizing a sustainable production system in coffee plantation such producing strategy would not only be economical to the farming community but also eco-friendly.

Serra and Pinero (1947) analyzing to economic position of coffee estates in Puerto Rico pointed out the need for a scheme for permanent rehabilitation of the coffee industry. Improvements for the production efficiency were suggested through improved varieties, machinery and chemical weed killers, greater diversification of crops was recommended to make better utilization of the land.
Satyanarayana (1954) studies about the yield / acre of coffee in India varies appreciably from year to as various factors influence the coffee yield. They may be climatic conditions and the occurrence or sufficiency of rainfall in each season, the location of the estate, the age of the plant, type of coffee grown, the size of the estate and so on. According to report, the average yield in Coorg is easily the highest and those of Madras is the lowest both in respect of arabica and robusta. The main reason for such a disparity may probably be the greater attention that is paid in Coorg for cultivation and larger manuring of spraying of the coffee estates.

Satyanarayana (1958) in his study reveals the present trend in plantation-of increased expenditure on chemical fertilizers and spraying materials with consequent beneficial effects on the yield/ acre. The increase in labour welfare, upkeep and depreciation costs are no doubt due to in part to the planter’s obligations under the Plantation Labour Act to provide increased amenities and housing to the estate labours. Attempts are being made to study the trends in the case of small estates also, but data available so far are too insufficient to draw useful conclusions and lack in accuracy.

Stalin et al. (1992) studied the effect of N, P, K and liming on the yield of Coffea arabica. Coffee bushes were given N + P₂O₅ + K₂O at 120+90+120, 160+120+160, 200+150+200 and 240-180-240 kg /ha annually and 1, 1.25 or 2.50 t CaCO₃ / ha in alternate years N, P and K were given in four splits in March, May, August and October. Ripe berry yield was highest (average of 5 years -8.93 t / ha) at the lowest NPK rate, although differences were not significant in the first and third years. Liming did not significantly increase coffee yield.

Selvaraj, A. and Gandhimati, P. (2003) in his study, discusses the production of coffee in different countries states in India and in different district of Tamil Nadu. From the analysis it was found that India ranks third in terms of area and production of coffee. Among the various states in India, Karnataka ranks first
followed by Kerala and Tamil Nadu. Dinidigul district ranks first in terms of areas and production of coffee.

Steven Rebello (2004) studied realized the potential of the bean, its important to keep abreast with all developments concerning coffee and make sure we are firmly entrenched in the value chain, and compensated for it. As growers, it is certainly important to have our voices heard and our presence felt with the right people, at the right places, we could hope for a fuller bodied tomorrow.

Venkataramaiah and Singh (1974) studied the accumulation of Copper in coffee soils as a result of continuous soraying of Bordeaux mixture over a period of 35-40 years. Accumulation of high amount of extractable Copper was observed in the surface soils from the arabica blocks and it decreased with depth. In contrast to this the soils from robusta blocks and forest showed a low content of extractable Copper. On an average 217 kg per ha of extractable Copper had accumulated in top 15 cm soil layer in sprayed arabicas compared to 24 kg/ha in unsprayed robustas and forest soils. High degree of correlation between acid extractable Copper in the soil and Copper content in the coffee leaf was observed.

Veena et al. (1995) studied all types of coffee being exported as well as unit prices have registered higher growth rates. Instant coffee prices were dictated by bilateral agreement during a study period, which has resulted in lower growth rate. The increased growth rate of all types of coffee have been a result of increased production, a strict quality control measures followed by Coffee Board and importers preference to Indian coffee in the world market.

Wallis (1964) classified the items of cost of production of coffee as:

1. Field Costs (expenses incurred in growing coffee).
2. Crop Costs (expenses incurred in harvesting, processing, dispatching and marketing).
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3. Overheads Actual - repairs to vehicles and equipments, general transport and central services (e.g. watch and ward)

4. Overheads Estimated - management, accountancy, rent.

Though both the classifications of cost items by Perkins and Wallis are more or less similar, Perkins has further classified the total cultivation expenses in “essential maintenance costs” which are of routine nature and “operational field treatments” which relate to growth and crop promoting operations. This classification provides additional information for analyzing the production efficiency.

Wallis (1970) in another study based on the available records from the coffee demonstration farm and a group of estates in Kiambu district, classified the costs as “field production expenses” and “processing expenses”. He observed that it was difficult to assess the real cost of production on small holding as the opportunity cost of family labour varied widely. He further concluded that if a small scale farmer was able to manage the coffee plantation without hiring labour, cost of production could be considerably low. As soon as it became necessary to hire labour, cost per unit of production would be greater than that on large scale farms.

Waters (1970) tried to isolate the higher cost producers in Kenya. The costing determinants on small holding and large holding sectors were examined with the help of the extensive sample surveys and cost output relationships. The nature of the relationship between average total cost (AC) and total revenue (TR) was established by a least square regression technique. A hyperbolic form of function was fitted as $AC = BO (TR)^b$. It was observed that as the size of the production unit increased, average cost decreased. He concluded that many producers in both the sectors were operating under loss.
References


