INTRODUCTION
Land, water, climate, flora and fauna are the basic natural resources for agricultural development, which are subject to various kinds of deteriorating influences. Since agricultural development cannot exist on a deteriorating natural resource base, it is imperative to develop strategies for conservation and improvement of resources. The concept of sustainable resource management implies that the needs of the present can be met without compromising the ability of the resources to meet the needs of the future. In the past, in view of the overriding concern for ensuring food security and meeting other vital requirements of the large and rapidly growing population, the pursuit of research and development was directed towards utilisation of resources to derive maximum benefits on a short-term basis. There is now recognition that truly productive agriculture must have long-term sustainability by way of sustenance of natural resources, economic viability and social acceptability of production systems and protection of environment.

The term sustainable agriculture is meant as a mode of farming through the use of ecologically sound management technologies such as crop diversification, organic soil management and biological pest control to provide long term sustained yields (Altieri, 1994). According to him the principles of agricultural sustainability is the optimisation of agro-ecosystems as a whole. Looking beyond production economics, he considers a wider definition of sustainable agriculture encompassing broader issues like ecological stability and viability, social equity, involvement of all forms of life and cultural acceptability. Pretty (1995) further elaborates that the concept should embrace long-term agricultural productivity with simple modification of conventional management techniques by closely monitoring and carefully managing flows of nutrients, water and energy at farm, regional and national levels to achieve a balanced high production level.

Exploitative agriculture offers great possibilities if carried out in a scientific way, but poses great dangers if carried out with only an immediate profit or production motive. Intensive cultivation of land without conservation of soil fertility and soil structure would lead ultimately to the springing up of deserts. Irrigation without arrangements for drainage would result in soil getting alkaline or saline. Indiscriminate use of pesticides, fungicides and herbicides could cause adverse changes in biological balance as well as lead to an increase in the incidence of cancer and other diseases, through the toxic residues present in the grains and other edible parts. Unscientific tapping of underground water would lead to a rapid exhaustion of this wonderful capital resource left to us through ages of natural farming. The rapid replacement of numerous locally adopted varieties with one or two high yielding strains in large contiguous areas would result in the spread of serious diseases capable of wiping out entire crops. Therefore, the limitations of exploitative agriculture without a proper understanding of the various consequences of every one of the changes introduced into traditional agriculture and without first building up a proper scientific and training base to sustain it, may only lead us into an era of agricultural disaster in the long run (Swaminathan, 1968). Such an action-reaction analysis would lead to the intensification of efforts in the areas of varietal diversification, development of integrated pest and nutrient management systems, improved soil health care, etc. Byerlee (1987) further suggest that a new and more complex second generation of inputs and management practices can play an important role in productivity growth, while keeping input use at reasonable levels. In other words investments in better Information and the skills of farmers to improve their technical efficiency are needed to maintain momentum in traditional green revolution areas.
Pathways towards sustainable farming in developing countries like India may differ dramatically from those applicable to developed countries; that is, technological options must be appropriate both to the needs and opportunities of such population-rich, but land-hungry country. There are at least two difficulties in applying the Fukuoka (1978) on do-nothing farming and LISA models to the circumstances of developing countries. Given the complexities inherent in achieving sustainable agricultural systems, especially in developing countries, we need to develop technologies that can help to increase the productivity and profitability of even small-farm operations, without forcing undue trade-offs between current and future production systems. Techniques like integrated nutrient supply (involving a blend of bio-fertiliser, organic and green manure, and mineral fertilisers), and integrated pest management (involving genetic, biological, and cultural control methods, as well as the application of chemical pesticides when needed), need to be further refined so as to achieve technical efficiency and ecological sustainability.

Country like India the only viable path towards sustaining the natural resource base of agriculture is by increasing the productivity. Creative blending of new and traditional technologies can help to achieve the needed improvements in agricultural productivity, employment and economic growth. However, no amount of effort to implement the appropriate mix of technologies will bring lasting benefits in the absence of enlightened public policies designed to facilitate and reinforce their adoption.

Agriculture continues to be the backbone of the Indian economy. A massive application of science and technology can enable Indian agriculture to face the serious challenges. For this, the nature and character of agriculture research and extension will have to change, building on its basic strength built through decades of experience. Commercialisation of agriculture in response to domestic and world market changes will induce drastic shifts in cropping patterns and resource use. This may have implications on sustainability. Land and water resources will face acute degradation stress. Supply of non-renewable resources like fossil fuels and phosphates will be constrained. Agro-chemicals may therefore gradually be substituted by biological inputs. Management of these including common property resources will pose economic and political challenges, which will need resolution. Organisations, communities, households and individuals will have to grasp this fact and live with it. Infrastructure will emerge as a major constrain in the short run as availability of public resources declines, in both domestic and export sectors. New institutional arrangements will evolve in factors and product markets. Technological change will emerge as the major determinant of agricultural growth. Even a modest decline in growth of productivity of crops will result in very large adverse effects.

Cotton, a gift of nature is the world's most important textile fibre, forming almost half of all textile fibres used and is one of the most important agriculturally produced raw materials. It plays a pre-eminent role in India's agrarian and industrial economy occupying one fourth of world's cotton area of more than 7.5 million hectares engaging more than one million farmers. Overall, about 60 million people depend on cotton cultivation, trade and processing for their livelihood. In India there are more than 1280 textile mills (comprising 908 spinning mills and 274 composite mills) having 28.48 million spindles providing employment to 1.2 million people, 1.55 million power looms employing more than 5 million people and nearly 4 million handlooms providing livelihood to 10 million weavers. The textile sector accounts for 7.5 per cent of the total gross domestic product and cotton is the predominant fibre accounting for nearly 73 per cent of the total fibre consumption in the country. The total value of cotton and its by-products currently produced in the country is estimated at around Rs.15000 crores. There are around 4166 ginning and processing units in the country, which guarantee seasonal employment to millions of people. On an average around 200 man-days
are utilised in the farming of cotton in a unit area a season (Rakesh et al., 1995). Besides cotton seed is a valuable by-product of cotton plant. It is the second important source of edible oil in the world and the fifth largest source in India with a potential of 0.8 to 1 million tonnes in 2001 AD. Many other by-products may help to meet the industrial needs and contribute to employment generation.

Since independence, remarkable progress has been made to substantially increase the cotton production and productivity both qualitatively and quantitatively as a result of intensive research and development efforts which not only has placed the country self-sufficient in raw cotton but also with good exportable surplus. Sustained efforts by scientists, development workers, farmers and suitable pricing, marketing and export policies have enabled the country to reach a record production of 155 lakh bales during 1996-97. Despite the phenomenal growth in production the average cotton productivity in the country is as low as 317 Kg as against the world average of 579 Kg per hectare, the low average productivity is mainly because 70 per cent of the area is under rainfed and seasonal incidence of insect pests and diseases in the irrigated areas, leading to instability in yield per unit area and fluctuating production levels.

The area under cotton is not likely to increase from the present 7.5 to 7.7 million hectares. The production has to be stepped up to 190 lakh bales by 2000 AD from 155 lakh bales (1996-97) to meet domestic consumption and reasonable exports. It will therefore be necessary to augment productivity to almost 50 per cent more than its present level. The area under irrigation is only 30 per cent and it is not likely to increase substantially in the near future. The country has recorded one of the world’s highest yield of 10 tones of seed cotton per hectare in hybrids under special growing conditions. In rainfed condition highest yield recorded with protective irrigation is nearly 3 tonnes. The gap in yield of cotton obtained in national demonstrations and in farmers’ fields in both irrigated and rainfed areas goes up to 100 per cent and is indicative of scope for increasing productivity through adoption of sustainable production technologies at farm levels under vahed cotton farming ecosystems.

Tamil Nadu is one of the nine major cotton growing States in India occupying an area of around 2.5 lakh hectares with an annual production of 5.0 to 6.0 lakh bales. There are six major agro-ecological zones of cotton cultivation and each zone represents different ecosystems and cultivation practices. Since eighties cotton area in the State has declined though productivity has gone up to around 315 Kg lint per hectare. The decline in area may be attributed to competition from other crops and reduced cotton yields due to adoption of unsustainable means of production practices particularly pest control. Realising this grave situation, since the last one decade farm scientists have been developing several system specific sustainable increased production technologies for adoption. The crop however continues to enjoy agricultural and economic importance in the State. More than 50 per cent of cotton textile mills in the country is situated in Tamil Nadu and its annual requirement of raw cotton is around 45 lakh bales though the production is as low as 5.0 to 6.0 lakh bales. Hence textile mills in the State presently depends mainly on upcountry cottons and imports to meet their demand. Since there is no scope for increasing the area, only option left out is to enhance productivity per unit area.

In the light of the above there is a need to quantify sustainability in cotton to make the concept operational duly incorporating its economic viability, environmental sustainability and social equity. Many individuals and organisations have attempted to identify certain indicators and then to work out an index for measuring sustainability at macro level (Anonymous, 1990, 1991b, 1992 and 1996; Stockle et al., 1994). Harrington (1992) opines that the ability to quantify sustainability is
crucial to make operational. Gowda (1996) made an in-depth farm level analysis of rice farming sustainability and Nagabhushanam (1997) analysed the sustainability of agriculture in watershed environment through identified indicators. However such micro level studies on sustainability for different agricultural crops including cotton are meagre and the felt need of the day is increasing and stabilising the productivity level of cotton, and this could be achieved by generating appropriate, low-cost and high production sustainable technologies by research system and maintaining linkage, among research, extension and client systems for effective transfer of such generated technologies. The research system takes care of technology generation and its output becomes the input of dissemination system, whose output becomes the input of the utilisation system. A process of feedback operates at all levels. Imbalance and malfunctioning in any one of the three systems or intermediate steps have been seen to cause problem (Singh, 1981).

The transfer of sustainable production technology is more difficult since agriculture is a risky business. This difficulty is compounded by the inadequate infrastructure facilities such as credit, inputs, storage, marketing and weakness of the extension agencies. The technology can be transferable only if it is low-cost, highly remunerative and location specific. The approach towards increasing yield by counteracting the impediments in the process of production such as pest and disease management, weed management etc, will help to contribute towards getting higher production and productivity. To match the technology with the felt needs of the farmers, it is essential to involve the farmers in the extension process and if necessary in the research system as well. Thus, to increase the production and productivity of cotton, the researchers, extension personnel and farmers are expected to play a vital role in the technology transfer process through effective linkage. Hence a comprehensive study on the information management pattern of researchers, extension personnel and farmers was also felt necessary. It is not only essential to know the methods of technology transfer but also the extent to which the different sustainable production technologies are adopted by the farmers which would further reduce the technological gap amongst farming system. Experiences in respect of the development strategies followed to improve the production of cotton crop revealed the existence of certain constraints in the way of adoption of recommended technologies. Therefore it becomes prerequisite to study the limiting factors responsible for adoption of technologies. Keeping the above facts in view, the present study has been contemplated with the following specific objectives.

1.1 SPECIFIC OBJECTIVES

i) To analyse long term trend in cotton area, production and productivity at world, national, State and ecosystem levels.

ii) To find out the contributions of profile characteristics of farmers on sustainable cotton farming.

iii) To find out and compare the operating efficiency of the indicators of sustainable cotton farming in different cotton ecosystems of Tamil Nadu.

iv) To study the information management pattern by farm scientists and extension personnel in sustainable cotton production technology transfer process.

v) To undertake constraints analysis as expressed by farm scientists, extension personnel and farmers on sustainable cotton farming and its technology transfer process.
1.2 SCOPE AND IMPORTANCE OF THE STUDY

The knowledge on trends in area, production and productivity is an important ingredient for perspective planning and policy decisions. Production of a crop is a function of area and average yield of the crop. Therefore the knowledge of contribution of area and productivity in the production of cotton crop could be of immense value in policy implications.

The study on assessing the characteristics of people practising cotton farming in different ecosystems would throw light on strong and weak points of each cotton ecosystem in the adoption of sustainable cotton farming practices.

The operational efficiency of various indicators under different cotton ecosystems is programmed to be quantified to make the concept adaptable and in this process the reasons for different levels of sustainability could be analysed and necessary corrective measures be suggested to overcome those lacunae.

The study on information management pattern perceived by farm scientists and extension personnel would enlighten the process of sustainable cotton farming technology transfer to the clientele.

Analysis on constraints faced by farm scientists, extension personnel and cotton farmers would help to formulate appropriate remedial measures for accelerating the information management pattern in different cotton ecosystems to achieve better sustainable growth.

1.3 LIMITATIONS OF THE STUDY

The constraints on resources, sample size, time and others that an academic researcher would normally encounter are not entirely ruled out in this study. Since the farmers in general did not maintain farm records about cultivation aspects, the data collected were subjected to their recall bias. However utmost care and precision were taken to elicit information from the respondents and cross-checks were made at several points to confirm the accuracy. Extensive efforts were made to select ideal locations in each distinct ecosystem so that results of the study could be easily made applicable to similar situations elsewhere.

1.4 LAY OUT OF THE THESIS

The thesis is divided into five chapters. Detailed sub-titles with reference to objectives set are also presented in the respective chapters. The first chapter on introduction describes a brief account of sustainable agriculture, statement of the problem, specific objectives, scope and importance of the study. The second chapter on review of literature deals with the relevant studies regarding the objectives. The third chapter on research methodology deals with the locaSe of research, sample and sampling, selection and measurement of variables, methods of data collection and statistical methods used. The salient results and discussions are presented in fourth chapter in a logical sequence to arrive at the answers to the objectives set forth for the study. Chapter five summarises the salient findings together with implications and suggestions for further research, followed by references and appendices.