SUMMARY AND CONCLUSION
The present Investigation on sustainable cotton farming and its technology transfer process in Tamil Nadu was carried out with the following specific objectives.

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

ii) To find out the contribution 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 ecosystems of Tamil Nadu

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

v) To undertake constraints analysis as expressed by farm scientists, extension personnel and farmers on sustainable cotton farming and its technology transfer process

The investigation was carried out at Udumalpet tract in Coimbatore district representing for winter irrigated, Theni tract in Madurai district for summer irrigated long duration rice-fallow, Kovilpatti tract in Tirunelveli district for winter rainfed, Konganapuram tract in Salem district for summer irrigated cotton succeeding groundnut/sugarcane, Kumbakonam tract in Thanjavur district for summer irrigated short duration rice-fallow and Villupuram tract in South Arcot district for cotton intercropped with groundnut, cotton ecosystems of Tamil Nadu, randomly selecting five villages in each of the system.

The respondents of the study were from research, extension and client systems. The research system consisted 91 farm scientists working across the six ecosystems. A total of 180 extension functionaries in the rank of agricultural officers, 30 from each agricultural division representing the six ecosystems were chosen. A fixed sample size of 50 farmers, ten from each of the five villages under each ecosystem was adopted.

Twenty-five profile characteristics of farmer respondents as independent variables were studied to measure their influence on the dependent variable sustainability. Fourteen indicators finally selected constituted the sustainability index.

The data were analysed through standard statistical procedures. The salient findings were presented below.

5.1 TREND IN AREA, PRODUCTION AND PRODUCTIVITY OF COTTON

5.1.1 World level: During the period from 1970-71 to 1996-97 productivity contributed much towards production rather than area, which remained stable over the period under study. The nature of instability in the growth of cotton production during the period was also found favourable implying almost consistent trend in output.
SA.2 National level (India): The rates of increase in production and productivity were higher than that of the world. The increase in production was mainly contributed by increase in productivity. However area under cotton remained stable over the period of time. Unlike in the case of world nature of instability was found to be unfavourable resulting in wide fluctuations in output.

5.1.3 State level (Tamil Nadu): The area under cotton was found to decrease over the period with only marginal increase in production which was more than compensated by increase in productivity. The nature of fluctuations in output was however found favourable.

5.1.4 Ecosystems in Tamil Nadu: Area and production registered a negative growth rate under winter irrigated and summer irrigated long duration rice-fallow systems although there was a marginal increase of productivity, whereas the decline in area under rainfed system was more than compensated by improvement in production and productivity. On the other hand in summer irrigated cotton succeeding groundnut/sugarcane, short duration rice-fallow and cotton intercropped with groundnut systems, increased growth rates in area and productivity together contributed for higher production. Further, variation in output was found to be favourable in all ecosystems except in winter irrigated farming.

5.2 CONTRIBUTION OF PROFILE CHARACTERISTICS OF FARMERS ON SUSTAINABILITY

5.2.1 Of the 25 profile characteristics of the farmer-respondents studied, fourteen variables such as family educational status, nature of family, farm size, annual income, farm implements and appliances status, material status, cotton farming intensity, outstanding credit, achievement motivation, level of aspiration, innovativeness, extension system link, research system link and socio-economic status were found to be heterogeneous in nature between systems. While comparing the systems it appeared that winter irrigated and summer irrigated long duration rice-fallow were more favourable in profile characteristics than other systems towards sustainable development.

5.2.2 Correlation, regression and step-up selection analyses of independent variables with sustainability revealed that personal characteristics cotton farming experience, situational variable community co-operation, psychological variables economic motivation and farming commitment and communicational factor extension system link had emerged as the most important factors that influenced sustainability in the study area.

Comparing the systems the data on correlation, regression and step-up selection clearly revealed that the relationship of situational variables farm size and annual income, psychological variables achievement motivation, innovativeness, economic motivation, value orientation and farming commitment and communicational factor extension system link on sustainability was distinct in winter rainfed system. Whereas in other systems variables namely nature of family, achievement motivation, level of aspiration, economic motivation, farming commitment and research system link in winter irrigated, material status, community co-operation, attitude towards sustainable farming and research system link in summer irrigated cotton succeeding groundnut/sugarcane, outstanding credit, extension system link and research system link in summer irrigated long duration rice-fallow, community co-operation, attitude towards sustainable farming and research system link in summer irrigated short duration rice-fallow and outstanding credit, achievement motivation and farming commitment in cotton intercropped with groundnut were the differing factors influencing sustainability. The contribution of independent variables appeared to be more in winter rainfed, cotton intercropped with groundnut and winter irrigated systems than others.
The importance of variables age, educational status, cotton farming experience, farm implements and appliances status and information source exposure appeared to be almost alike in all systems on the dependent variable.

In path analysis out of 25 independent factors, farm implements and appliances status, material status, community co-operation and farming commitment were found to show highest direct positive effect, socio-economic status, attitude towards sustainable farming, farm power and age with negative direct effects and socio-economic status, farm implements and appliances status, material status and farming commitment with substantial indirect effects in the study area. It clearly established the impact of situational variables socio-economic status, farm implements and appliances status and material status and psychological factor farming commitment towards sustainability.

While comparing between systems on various effects, it was also evident that the direct positive effect of the variable farm implements and appliances status was predominant in winter irrigated and summer irrigated short duration rice-fallow, material status in winter irrigated, summer irrigated short duration rice-fallow and cotton intercropped with groundnut and community co-operation in summer irrigated long duration rice-fallow and cotton intercropped with groundnut systems. Further the factors socio-economic status, educational status, nature of family, occupational status, farm status, information source exposure, research system link, farm power and material status had direct negative effect in all systems except in summer irrigated long duration rice-fallow and summer irrigated cotton succeeding groundnut/sugarcane systems and age, barring summer irrigated long duration rice-fallow, winter rainfed and summer irrigated short duration rice-fallow systems.

In substantial indirect effects the variable socio-economic status was found to emerge as important variate in all systems except in summer irrigated long duration rice-fallow and winter rainfed systems. Similarly, farm implements and appliances status and material status had prime role in all systems excluding summer irrigated long duration rice-fallow and cotton intercropped with groundnut systems. It was also found that the influence of some factors differed from system to system. For instance, the importance of achievement motivation was evident in summer irrigated long duration rice-fallow, winter rainfed and cotton intercropped with groundnut, farm size in summer irrigated long duration rice-fallow and winter rainfed, research system link in summer irrigated long duration rice-fallow and summer irrigated cotton succeeding groundnut/sugarcane, occupational status in summer irrigated long duration rice-fallow and winter rainfed, annual income in winter irrigated and winter rainfed and research system link in summer irrigated long and short duration rice-fallows systems.

5.2.3 In the principal component analysis seven factors, viz., educational status, level of aspiration, innovativeness, farming commitment, research system link, community co-operation and socio-economic status influenced either any one or more components of sustainability. Community co-operation showed negative significant relationship and contribution under correlation, regression and step-up selection analyses towards Principal Component-I (PC-I). Whereas innovativeness and farming commitment had positive influence on Principal Component-II (PC-II) and Principal Component-III (PC-III) respectively. Educational status in PC-II and research system link in PC-III were found to be the important factors in correlation and step-up selection. Level of aspiration had negative contribution with component-III. There was strong positive association in respect of socio-economic status with component-I and III as revealed by correlation coefficients.
Among the four variables having largest direct positive effect in the respective components, these variables appeared to be specific in effect to each component. Yet the variable socio-economic status influenced both PC-II and PC-III. The favourable impact of material status and farming commitment emerged in pooled criterion variable (Y) was also important for PC-I and PC-III.

In the substantial indirect effect the variable material status was important in all the components while educational status was crucial in PC-I and PC-II and socio-economic status and farm implements and appliances status in PC-II and PC-III. All the crucial factors found in pooled criterion variable (Y) were also found to act in one or other components.

Comparing the three components of sustainability in relation to independent factors based on correlation, regression and step-up analyses it was observed that the impact of explanatory variates varied widely over the criterion variables. In the present study favourable influence of cotton farming intensity and attitude towards sustainable farming on Principal Component-I in winter rainfed system was evident. The factor community co-operation had favourable effect on Principal Component-II in summer irrigated cotton succeeding groundnut/sugarcane.

Family education explained variation in Principal Component-I in summer irrigated cotton succeeding groundnut/sugarcane. Farm power in cotton intercropped with groundnut and cotton farming intensity in winter irrigated cotton ecosystems had favourable effect on Principal Component-III which were not expressed in the results reported in the analysis involving the criterion variable (Y). The contribution of other variables but for materials status appeared to be not less important in influencing the three components of sustainability. It is interesting to note that socio-economic status was highly correlated in all the three components and six systems.

Direct positive effects on socio-economic status, research system link, material status, educational status, level of aspiration and economic motivation were found to exists on either any one or all the three components of sustainability. The influence of remaining variables could be noticed in both Principal Component-II and III or in any one. However the effects differed from system to system. By comparing the pooled and decomposed components of sustainability, it could be clearly inferred the role of these newly emerged variables in influencing the criterion variate.

In substantial indirect effect the most important variables were farm implements and appliances status, socio-economic status and material status in all the components of sustainability and in almost all systems. This trend was also witnessed in the analysis of pooled criterion variate in systems. The impact of some newly emerged important variables from component analysis differed between components of sustainability and systems.

5.2.4 Study on inter correlation of profile characteristics, sustainability and its three components revealed that the independent variables were specific in their operational effect in study area as well as in different ecosystems. It is also interesting to note that variables educational status, farm size, farm implements and appliances status, achievement motivation, farming commitment and extension system link did not show spectacular operational effect under conditions studied.
5.3 OPERATING EFFICIENCY OF INDICATORS OF SUSTAINABLE COTTON FARMING

In the study area nearly 70 per cent of the farmers represented medium level of sustainability with almost equal distribution of low and high categories. Between systems also the same trend was observed.

The analysis of variance of mean sustainability indices indicated that cotton intercropped with groundnut, summer irrigated short duration rice-fallow and winter rainfed systems were relatively better than other systems. However the mean indices of the three Principal Components of sustainability indicated that cotton intercropped with groundnut, summer irrigated long duration rice-fallow and summer irrigated cotton succeeding groundnut/sugarcane had higher indices than others.

Critical analysis of mean indices of indicators in each component of sustainability disclosed that the impact of indicators falling under each component generally differed between systems. Productivity, government policies and marketability of PC-II in winter irrigated system were found to have favourable operational effects towards sustainability.

Infrastructure accessibility of PC-II in summer irrigated long duration rice-fallow, technological appropriability and output/input ratio of PC-III and environmental soundness and stability of PC-I in winter rainfed, water management of PC-I in summer irrigated short duration rice-fallow systems had favourable effect. Information self-reliance of PC-III had positive gain in its functional effect in all systems.

Integrated pest management, environmental soundness, input self-sufficiency, and stability of PC-I in summer irrigated cotton succeeding groundnut/sugarcane had favourable response. Integrated pest management, environmental soundness and input self-sufficiency of PC-I and integrated nutrient management of PC-II were found to influence sustainability in cotton intercropped with groundnut.

Inter correlation between indicators of sustainable cotton farming in the study area suggested that technological appropriability, environmental soundness, marketability and government policies and their associated variates had enhanced sustainability gain in cotton farming. The micro level studies indicated varied levels of influence of the indicators across ecosystems towards sustainability. Data further suggested for strategic improvement of integrated pest management in winter irrigated, integrated nutrient management in summer irrigated cotton succeeding groundnut/sugarcane, government policies in summer irrigated long duration rice-fallow and technological appropriability, integrated nutrient management, integrated pest management, output/input ratio, environmental soundness, information self-reliance, marketability and infrastructure accessibility in cotton intercropped with groundnut and short duration rice-fallow systems to create favourable situations for additional gains in sustainability.

Studies on correlation and regression of indicators with sustainability explained the following functional effects of the indicators in the study area and systems.

In the study area technological appropriability, government policies and environmental soundness were important favourable indicators influencing sustainability. In contrast water
management had negative influence. Marketability was found to show positive correlation with sustainability.

On comparing systems, it was inferred that technological appropriability was found to work more efficiently in winter rainfed and summer irrigated short duration rice-fallow than in other systems.

Integrated nutrient management was found to show positive influence in summer irrigated cotton succeeding groundnut/sugarcane whereas it was reverse in winter irrigated and rainfed systems.

Integrated pest management had shown marginal impact in all systems except in cotton intercropped with groundnut where it was found to be ineffective to promote sustainability.

Information self-reliance was found to be inadequate in winter rainfed and summer irrigated cotton succeeding groundnut/sugarcane systems.

Marketability was favourable in cotton intercropped with groundnut while it was not Beneficial in summer irrigated short duration rice-fallow system.

Water management practices appeared to be ineffective on sustainability in summer irrigated cotton succeeding groundnut/sugarcane and cotton intercropped with groundnut systems.

Output:input ratio had positive trend in all systems except in summer irrigated long duration rice-fallow and winter rainfed systems where the outputs were relatively less.

All systems generally exhibited favourable trend in productivity.

Stability (measured on realised yield in proportion to expected yield) was found favourable in all systems except in summer irrigated long duration rice-fallow where yield fluctuations were much.

Use of own resources (input self-sufficiency) was found to be more by farmers in all systems except in summer irrigated cotton succeeding groundnut/sugarcane wherein the farmers were mostly depending on purchased input.

The environmental conditions in different ecosystems had no adverse effects due to the adoption of sustainable cotton farming technology.

The ability of cotton farmers to possess Information required for sustainable cotton farming and utilising them for decision making was not adequate in winter rainfed and summer irrigated cotton succeeding groundnut/sugarcane systems.

The existing decision making pattern of farmers did not make any change on sustainability.
Infrastructure accessibility through institutions or organisations providing physical and capital resources including transport and services did not make any influence on sustainability in all systems.

Policy environment created by governments on issues related to cotton production through various acts, legislation, cotton export and import policies etc., had positive impact on sustainable cotton farming in the study area although farmers need greater awareness on general agricultural policies of Central and State governments. The finding that awareness of policies is low which is a useful information for government in that they can raise awareness of these as they are also found to influence sustainability positively.

The reasons for differential effects of these indicators could be attributed to adoption pattern and heterogeneity in profile and the resistances of farmers within the carrying capacity of the system concerned.

It could also be inferred that all the systems were sustainable with reasonable levels of productivity within the carrying capacity of the system concerned. By use of ecosystem specific technology and its efficient transfer and effective adoption, it is possible to achieve sustainable growth in cotton output in the immediate future.

5.4 INFORMATION MANAGEMENT PATTERN AND SUSTAINABLE COTTON PRODUCTION TECHNOLOGY TRANSFER PROCESS

5.4.1 Farm Scientists

5.4.1.1 Information input pattern: Farm scientists derived support to research ideas mainly through self observation, research articles published through print media, farmers, professional meetings, farm broadcast and seminar/workshop/summer institute.

5.4.1.2 Information processing pattern: Discussion with fellow scientists, referring literature, discussion with extension personnel, conducting experiments, discussion with experts within State and in research committees were the most used methods for exploring probable solutions for problems encountered by farm scientists.

Farm scientists evaluated research findings by discussion with fellow scientists, examining the validity of research findings in farmers’ fields and in research stations, analysing in the light of past experience, and considering the technical feasibility of the information. Apart from this, judging on the basis of socio-economic and agro-climatic conditions were also considered. They preserved information by maintaining subject wise files, reference cards and common notebook. Popular research articles and research reports, lecture notes and charts and graphs were the major information transformation techniques followed by them.

5.4.1.3 Information output pattern: Major individual contact methods used by the farm scientists for dissemination of technical "know-how" and "do-how" were farm and home visit, advisory letters to farmers and office calls to farmers and extension personnel. Training lectures to extension personnel and farmers and field day lectures as well as method demonstration were the most important group contact methods used by them. Research and popular articles, organising
exhibitions and field days, farm broadcast and distribution of handouts were frequently used for mass contact.

5.4.1.4 Perception of linkage: Around two-third of farm scientists had expected level of linkage with farmers followed by more than 50 per cent of them with other research organisations/ scientists and other development departments/extension personnel.

5.4.1.5 Perception on feedback: Scientists expressed that they received feedback at expected level and above from farmers whereas it was far less from extension personnel.

5.4.1.6 Expectations and suggestions of farm scientists: Majority of the farm scientists opined that farmers should be educated through training on the optimal use of natural resources integrating with pest and nutrient management in the production technology and conducting front-line and on-farm demonstrations in large scale. Identification of constraints to productivity in different ecosystems through feedback mechanism and finding solutions etc, were also suggested.

5.4.2 Extension personnel:

5.4.2.1 Information input pattern: Newspaper, Kharif (winter) and Rabi (summer) campaign meetings and farm journals and magazines followed by demonstrations/trials, farm broadcast and training camps were the most used information sources by extension personnel.

5.4.2.2 Information processing pattern: The most utilised evaluation methods were discussion with progressive farmers and fellow workers. The other frequently used methods were examining the validity of conclusions, discussion with higher-ups in the department, analysing in the light of past experience and cross checking it against past recommendations.

The most commonly used information preservation methods by the extension personnel were maintaining a common notebook, memorising and maintaining subject wise files. To transform the technical message into practice by farmers, the methods such as radio talk, simple package of practices, lecture notes, charts and graphs, leaflets and handouts and cyclostyled materials were found to be utilised by them.

5.4.2.3 Information output pattern: Farm and home visits and trials and demonstrations were the most used individual contact methods by extension personnel. Field trips, general meetings, training lectures to farmers and field day lectures and method demonstration were the widely used group contact methods. Campaigns, farm broadcast, news articles, exhibitions and handouts were the popularly used mass contact methods.

5.4.2.4 Perception on linkage: Over 70 per cent of the extension personnel opined that their interaction with other development/extension personnel and research organisations/scientists was at expected level and above.

5.4.2.5 Perception on feedback: Over three-fourth of the extension personnel received feedback information at expected level from farmers.

5.4.2.6 Expectations and suggestions of extension personnel: More than 70 per cent of the extension workers had suggested for developing location specific, disease and pest resistant cotton varieties/hybrids and adoption of integrated nutrient and pest management technologies. Majority of
them had also suggested inter-alia issues relating to technological upgradation of rainfed cultivation, integrated pest management, implements, crop rotation, water harvesting, development of location specific recommendations, integrated nutrient management towards organic farming, intensive training and demonstrations to farmers, conduct of large scale demonstrations in farmers fields, village adoption and extensive use of mass media and favourable government policies on providing separate extension personnel for intensive field work, supply of quality inputs, organised marketing and pricing and EXIM policy.

5.5 CONSTRAINTS ENCOUNTERED BY FARM SCIENTISTS, EXTENSION PERSONNEL AND FARMERS

5.5.1 Farm Scientists: Overwhelming majority of farm scientists opined that the existing cotton production technologies were not adequate for sustainable development. Constraints from inadequate financial resource and existing government policies relating to export and imports, pricing etc. were reported. More than 70 per cent of the respondents felt that dimensions like uneconomical returns upsetting benefit cost ratio of the farmers, inadequate infrastructure facilities sufi as precision equipment, laboratory facilities etc., laek of co-operation from farmers while conducting field trials and demonstration, inadequate manpower for effective execution of field work often hindered technology development and transfer. Issues such as non-availability of quality inputs in local market and poor accessibility to electronic media such as computer, E-mail, internet etc., on international cotton literature were also reported to hold back the progress in the process of technology development.

5.5.2 Extension personnel

5.5.2.1 Structural and administrative constraints: Majority of the extension workers in all the ecosystems were facing shortage of qualified manpower in the organisation.

5.5.2.2 Functional constraints: Nature and intensity of functional constraints differed among systems. More than 60 per cent of respondents in all the systems experienced strained state of relationship among functionaries in the organisation resulting in ineffective performance except in cotton intercropped with groundnut as well as laek of manpower for transfer of technology work barring winter rainfed systems.

5.5.2.3 Socio-economic constraints: Various socio-economic constraints are system specific. However delay in releasing of funds was experienced as the major constraint in all systems.

5.5.2.4 Technological constraints: Insufficient training, laek of training aids, monotony, no creativity and risk in transfer of technology work as well as laek of efficiency in project management were stated to be the bottlenecks encountered by extension personnel. However, these drawbaeks differed between systems suggesting refinement of existing technologies specific to cotton systems.

5.5.3 Farmers

5.5.3.1 Bio-physical constraints: Comparing the various bio-physical constraints between systems it was found that emergence of resistant type of pest, more incidence of pests and diseases, heavy weed infestation, unable to eradicate weeds were the major biotic stresses in all systems except in summer irrigated long duration rice-fallow and winter rainfed. Occurrence of low rainfall and drought was reported to be common phenomena in all systems barring summer
irrigated long duration rice-fallow. Lack of soil moisture retention was quite conspicuous in winter rainfed followed by short duration rice-fallow and cotton intercropped with groundnut systems. The latter two systems were also prone to flood due to their geographical position. Winter rainfed and intercropping with groundnut systems were more often subjected to unfavourable agro-climatic conditions than other systems. Lack of soil fertility, levelling and drainage as well as unsuitable land conditions were the less endowed physical environment under summer irrigated cotton succeeding groundnut/sugarcane and cotton intercropped with groundnut systems.

5.5.3.2 Input and infrastructure constraints: Comparing the ecosystems data indicated that summer irrigated long duration rice-fallow and winter rainfed were relatively less susceptible to the pressures of input and infrastructure problems as compared to other systems. Further it was clearly observed that problems arising from ineffectiveness of plant protection Chemicals, inadequate supply of electricity for irrigation, lack of soil testing facility, ineffectiveness of weedicide and lack of storage facility were found to be high in the remaining systems. Intensity of other issues varied from system to system indicating their system specific nature.

5.5.3.3 Technological constraints: The major constraints arising from resurgence of pest, plant protection measures, complicated process involved in field application leading to unconvincing results, heavy fertiliser requirement of the crop and above all existence of knowledge gap in field application had caused serious concern on technological appropriability in all systems except in summer irrigated long duration rice-fallow and winter rainfed where the problems were lesser in magnitude.

5.5.3.4 Communicational constraints: Lack of advice, guidance and credibility of the extension personnel and inadequate exposure to technology through training were experienced in all systems. However, farmers under summer irrigated long duration rice-fallow and winter rainfed systems were found to receive relatively more effective communication as compared to other systems.

5.5.3.5 Socio-economic constraints: High labour wages was the key concern in all systems. Problems due to low remuneration, statutory kapas price and market price, lack of credit facilities, high production cost, non-availability of skilled workers, over emphasis on quality of cotton by buyers, glut in the market, high cost of manure and low adoption by neighbours were confronted in all systems but the intensity was found to be relatively less in summer irrigated long duration rice-fallow and winter rainfed systems. Concern over issues such as lack of draught animals, fragmentation of land holdings, difficulty in carrying farm yard manure to the field due to inaccessibility and inequity in irrigation water distribution were found to be system specific.

5.6 EMPIRICAL MODEL

The empirical model showing the route of transmission of cotton production technologies and the relationship between variables and sustainable cotton farming is depicted in Fig.16.

5.7 IMPLICATIONS

Results of the present study have brought out few implications for policy makers, administrators, extension personnel, researchers and farmers who are concerned with sustainable and accelerated cotton growth and development.
5.7.1 Cotton farming is moderately sustainable in Tamil Nadu across production systems. The state cannot afford to have this situation to continue considering the agricultural and economic importance of this crop and the need for its increased production to meet the requirement of Textile industry. Fortunately all the production systems have shown high productivity potential with moderate levels of sustainability raising the hopes of sustainable increased production. The findings also suggest that effective extension methods need to be extended to those farmers who at present are not achieving sustainable standards duly taking into account of their resource poor conditions. In order to achieve sustainable accelerated growth concerted efforts to strengthen research, extension, infrastructure development and marketing fully backed by State and central governments are needed through a national policy.

5.7.2 Majority of the farmers represented medium levels of sustainability with almost equal distribution of low and high categories in all the ecosystems. The profile characteristics of cotton farmers are found to differ from system to system influencing sustainability. To ensure their effective participation in high sustainable farming, there is need for further strengthening farmers' training and Farmers Field Schools (FFS) in their own fields as what works in one village may not work in another. Such training should provide emphasis on imparting knowledge and skill, continuous observation, feed back from local environments, enhancing local decision making capacity, group learning, encouraging formation of local groups for better linkages between farmer-to-farmer exchanges for information exchange and dissemination, fostering rural partnership for action, encouraging formal adoption of participatory methods and processes enabling them to develop plant scale improvement towards sustainable productivity.

The findings confirm that high status is associated with sustainability. These variables including socio-economic status are all features of progressive farmers. It was also shown that socio-economic status was associated with PC-III, a component of which is technological appropriateness. This suggest that technology is perhaps appropriate to higher status farmers. The policy makers may therefore evolve suitable strategies to reach out the resource poor farmers.

5.7.3 It may also be thought of to initiate schemes to promote agricultural technology education in schools especially to benefit students from rural areas and under privileged classes.

5.7.4 Enterprises other than farming such as livestock, poultry, aquaculture, sericulture etc. need be encouraged and supported for mobilising financial resources of farmers to meet their unmet minimum needs.

5.7.5 Analysis of sustainability indicators had revealed varied functional effects from system to system. Hence there is a greater need to strengthen research efforts to develop/retune location specific integrated, intensive production, protection and management technologies through multi disciplinary and multi location approach. In this context research activities have to be upscale in each system.

5.7.6 Priorities on research and development are also to be dovetailed towards attainment of sustainable enhanced productivity. Apart from techno-infrastructure, marketing and pricing do play vital role to realise economic return which will ensure sustainability.
5.7.7 In the present study market support has not shown favourable effect towards sustainability except in cotton intercropped with groundnut system. In the interest of the economy government should pursue a long term pragmatic policy on marketing and pricing which will take into account the needs of farmers who are the primary stake-holders in production as well as traders, textile industry, State agencies, co-operatives and non-governmental organisations.

5.7.8 The role of implements and appliances in enhancing sustained cotton productivity was evident. Hence suitable, efficient, cost-effective machineries and appliances need be popularised across the systems to reduce human drudgery as well as to carry out timely operations. A mechanical harvester for cotton to suit even for small and marginal farmers need be developed.

5.7.9 Biotic and abiotic stresses have often lead to instability in cotton yield as revealed in the present study. All these adverse development can only be averted if the State had a well functioning crop insurance scheme which should be truly comprehensive unlike the present crop insurance scheme.

5.7.10 Information management studies have shown few weak linkages in technology generation, dissemination, adoption and feedback mechanism between research, extension and client systems. There are few options like training and capacity building in the use of community development and participatory methods occur in the field and the explicit adoption of farmer-to-farmer extension methods. While evaluating new innovations and in the process of technology transfer discussion with progressive farmers must receive proper attention in future extension methods to enhance sustainability. As the farmers develop expertise, they are more capable of making demands from research and extension agencies.

5.7.11 In the era of information highways, it is often felt that farm scientists, extension personnel and farmers are not having easy access to information they are looking for. The frontier agricultural information technology has to be tapped using specialised skills and techniques for computer-aided agricultural extension and research systems and also for disseminating messages through information shops to clientele farmers.

5.7.12 Data obtained from space-borne remote sensing satellites can be used to obtain adequate and relevant information to monitor the natural resources, particularly those affecting agricultural practices.

5.8 Pointers for future research

i) The identified indicators and index developed thereby can be effectively used to measure sustainability levels of cotton in different cotton growing tracts of our country.

ii) The findings if confirmed in other cotton growing belts, methodology and tools used in the present study may be standardised by suitable modification in terms of addition, replacement or deletion of indicators without reducing the validity of such indices.

iii) The use of sustainability index developed from the study may be extended for similar studies on other crops.
FIG. 16 Empirical model on sustainable cotton farming and its technology transfer process.